DOCUMENT RESUME

ED 248 653 EC 170 432

AUTHOR Dansereau, Donald; Brooks, Larry W.
TITLE Transfer of Learning from One Setting to Another
PUB DATE Jun 84
NOTE 123p.; In: Areson, Ann H., Ed. and DeCaro, James J., Ed. Teaching, Learning and Development: Volume I. See EC 170 424.
PUB TYPE Information Analyses (070) -- Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Deafness; Generalization; Hearing Impairments; *Learning Processes; Learning Strategies; Postsecondary Education; *Skill Development; *Teaching Methods; *Transfer of Training

ABSTRACT

Part of a collection of papers commissioned by Foundations, a career development project sponsored by the National Technical Institute for the Deaf (NTID), the paper reviews research on transfer of knowledge and skills from one situation to another. A transfer classification scheme is proposed based on the notion that an individual's knowledge can be divided into two general categories: content and skills. In one section, research on content to content transfer (the impact of content knowledge learned in one situation on subsequent acquisition of new content knowledge) is reviewed. Traditional studies of transfer with word lists are briefly discussed, followed by a review of the research on the retention and transfer of meaningful verbal learning. Task, instructional, and learner variables are also considered. Recommendations include using concrete instructional materials liberally supported by pictures and illustrations, and tailoring methods to fit the styles, aptitudes, and preferences of learners. The next section focuses on skills to skills transfer (transfer of learned skills from one situation to another), including an examination of research on cognitive and motor skills. Recommendations include presenting knowledge relevant to acquiring a new skill without an excess of distracting stimuli. The next section examines skills to content transfer (skills that subsequently facilitate the acquisition, retention, retrieval, and transfer of knowledge). Recommendations center on the importance of stressing learning strategy skills rather than rote memorization. A final section discusses the educational implications of transfer-related research, specifically regarding instructional material development, teaching methods, and supplementary courses in learning and problem solving. (CL)

Transfer of Learning From One Setting to Another

Donald Dansereau

and

Larry W. Brooks

SECTION I: INTRODUCTION

The major purpose of this paper is to identify teaching and learning principles that facilitate the transfer of knowledge and skills from one situation to another. Of particular importance will be the implications of these principles for the technical education of the hearing impaired. Before reviewing the relevant literature, an overall framework for examining the factors that influence the efficacy of transfer will be presented.

The primary goal of education is to facilitate transfer: that is, to provide students with knowledge and skills that will lead to improved performance in subsequent situations (other courses, on the job, etc.). Unfortunately, much of the research on transfer has not been particularly informative. Voss (1978) echoes this point: "In some ways, our relatively poor understanding of transfer is amazing, since our educational systems are based fundamentally upon assumptions of transfer." (p. 14). Part of this lack of understanding may arise from inadequate analyses of the necessary and sufficient conditions for positive transfer. The prior research in this area has primarily focused on the acquisition of simple word lists and simple skills (e.g., pursuit rotor tasks). As will be pointed out later, the relevance of much of this research for complex, meaningful learning is suspect. Further, most of the transfer research has been done from a behavioristic perspective where the emphasis has been on determining input-output (stimulus-

response) relationships. The role of the learner has been virtually ignored in these studies. This is unfortunate in that there is growing evidence that the prior knowledge and skills of the learner are of crucial importance in understanding and predicting both learning and performance (Bower, 1973; Dansereau, 1978; Rothkopf, 1966).

As a step toward alleviating these difficulties a framework for examining transfer is presented in Figure #1. This framework incorporates ideas from a number of authors in the transfer domain, most particularly those of Gagne and White (1978). The basis of this framework is that learning and transfer involve complex interactions between the learner (viewed as a collection of knowledge, skills, and motivations) and the characteristics of the task (e.g., types of materials and instructional manipulations). An example of the importance of examining the learner-task interaction is illustrated by the finding that individuals with high levels of knowledge and skills benefit more from trial and error learning, while individuals with lower levels of knowledge and skills benefit more from teacher-guided learning (Snow, 1977). It is further suggested that the interactions between learner and task can be compensatory in either direction (i.e., good teaching can compensate to some extent for inadequate learning skills and vice versa). In exploring these interactions it is useful to examine the nature of learner and task characteristics separately. In Figure 1 learner characteristics have been divided into two major categories: knowledge and skills that are

specifically related to the content of the task at hand and knowledge and skills that are used to learn and perform in a variety of tasks regardless of content. For example, in learning how to operate a printing press, the student would bring to the situation content-specific knowledge and skills arising from previous experiences with printing presses or similar machines. The same student would also bring to the task relatively content-independent learning and problem-solving strategies that have been acquired from experiences with many types of tasks and/or from direct "strategy" instruction. The extent to which the student can use both these content-dependent and content-independent experiences in facilitating performance with the task at hand depends largely on what has been stored in the student's memory, how it has been stored, and the availability of cues for retrieval of the appropriate, stored information. In general, the content and structure of the student's memory is the major mediator between original learning and subsequent performance on a transfer task. From this perspective, the job of understanding transfer and the learning and teaching principles that facilitate it becomes largely one of determining what types of memory structures are necessary and sufficient for effective performance on a particular class of transfer tasks. Once the nature of these memory structures is determined, the next step is to delineate the teaching and learning strategies that would promote the development of these structures.

Gagne and White (1978) have identified four types of organized memory structures relevant to retention and transfer: (a) networks of propositions, (b) intellectual skills, (c) images, (d) episodes. Propositions are typically conceived of as subject-predicate constructions put together according to syntactic rules (such as those relating actors and actions, objects and attributes, actions and recipients). These may be represented by nodes containing concepts and links representing the relationships between two or more concepts. A simple example of a verbal proposition would be "For every action there is an equal and opposite reaction." Various types of propositional memory structures have been advocated by a growing number of cognitive theorists (e.g., Anderson & Bower, 1973; Bower, 1975; Rumelhart, Lindsay & Norman, 1972).

The term "intellectual skills" has been used to designate the learned memory structures that underlie the identification of concepts and the application of rules. This term has been prominently employed by Gagne (1972, 1976) to refer to the learned capability of "knowing how." In more general treatments of information processing models, intellectual skills are sometimes referred to as "action plans" or "sub-routines" (Bower, 1975). Such skills have also been described as "procedures" and "programs" by those who relate them to computer operations in artificial intelligence (Minsky, 1975; Winograd, 1972). One example of an intellectual skill might involve knowing how to make use of the proposition, "For every action there is an equal and opposite reaction," in playing a game of billiards.

Image memory structures are representations that correspond more or less directly with concrete things. Images may be visual, auditory, haptic, or some combination of these; it is generally agreed, however, that visual imagery is the most pervasive and generally useful kind. A comprehensive account of imagery and its relation to verbal processes of memory is given by Paivio (1971). Although there is substantial debate on the efficacy of imagery as a theoretical construct (Pylyshyn, 1973), its usefulness in improving the predictions of learning outcomes is well established. An example of an image structure would be a mental picture of two billiard balls colliding and obeying the action-reaction proposition.

The final memory structures identified by Gagne and White are episodes. Tulving (1972) conceived of the episode as a structure that stores information about temporally dated events and also about temporal-spatial relations among these events. A most important property of episodic memory is its "autobiographical" nature. Episodes represent events directly experienced by the learner and stored in such a way that the learner can recall that "I did such and such, in such and such a place, at such and such a time" (Tulving, 1972, p. 389). Remembering the details of a particular game of billiards that you played would be an example of retrieval from episodic memory.

As a result of their review of the relevant literature, Gagne and White proposed the model illustrated in Figure 2 as a representation of the interrelations of four different kinds

of memory structures and the learning outcomes to which they may be related. These authors suggest the following:

> The model presented in this paper predicts that when knowledge is stored as a proposition or as an intellectual skill, its outcome effects in retention and transfer will be greater the more extensive are its associations with interlinked sets of propositions, intellectual skills, images, and episodes. Most of the studies reviewed in previous sections may be seen as dealing with different patterns of memory structures in learners. One treatment may have emphasized involvement in personal activity, which should encourage the formation of a stable episode, whereas another has emphasized colorful demonstrations that should lead to the formation of images.
>
> Our review indicates conflicting results in a number of instances of sets of studies addressed to the same question. The model suggests an interpretation of such discrepant results--namely, that a given treatment may not have induced the type of memory structure that was specifically intended. Laboratory-based instruction or a demonstration by the teacher may lead equally to image formation; a dramatic demonstration may give its watchers a more stable episode than a routine laboratory exercise. A picture may fail to form a retrievable image if learners are not encouraged to process the stimulus. Furthermore, an image may be ineffective for retention if instruction

has failed to link the image with the propositions or skills it is supposed to support.

For these reasons, the model implies that research investigations should include measures of the memory structures actually formed. Past studies have generally made the assumption that seeing a film, playing a simulation game, or performing a laboratory exercise, each results in the establishment of a different memory structure. Differences in learning outcome (knowledge stating or rule using) have been tested, but independent assessments of the mediating structures have not been obtained. When a difference in outcome fails to appear in such studies, it cannot be known whether the instruction itself was ineffective in establishing different memory structures, or whether the latter do indeed have differential effects. (pp. 209-210)

In summary, Gagne and White concluded that teaching and learning manipulations that lead to the formation of highly integrated, multiple memory structures (sets of propositions, intellectual skills, images and episodes) are most likely to lead to effective retention and subsequent transfer. Although the present authors agree with this conclusion, it is suggested that the existence of integrated memory structures in some cases is a necessary but not sufficient condition for effective transfer. In order for transfer to take place the individual must be able to determine from the transfer task constraints which information and skills are relevant. The individual must

also be able to retrieve the relevant information and apply it correctly to the task at hand. These latter skills may be substantially content-independent and thus may be a part of the individual's repertoire of general learning and problem solving strategies. Consequently, if these skills are not available and if compensatory guidance through the transfer task is not provided by an instructor, supervisor, etc., then effective transfer will not occur. Sufficient conditions for transfer thus require the student to have integrated, content-relevant knowledge and skills as well as general, content-independent learning and problem solving skills that will allow the individual to retrieve and apply the content related information. A more detailed discussion of the nature of this stored information and teaching and learning procedures that promote its acquisition will be presented in subsequent sections

Clearly, the difficulty involved in applying stored knowledge and skills to a new task will depend not only on the learner, per se, but also to a large extent, on the nature of the transfer task; its similarity to the original learning situation (or more directly, its compatibility with the student's stored knowledge and skills), the salience of cues for appropriate retrieval of the stored information, etc. Therefore, in understanding transfer it is necessary to examine not only the cognitive characteristics of the individual and the teaching and learning principles that produced these characteristics, but also the nature of the transfer tasks that the individual may expect to encounter.

The remainder of the paper will discuss research relevant to different types of transfer situations. To provide a framework for this discussion, a transfer classification scheme has been developed based on the notion that an individual's knowledge can be divided into two general categories: content and skills. Content knowledge consists of relevant facts, concepts, and terms associated with particular topic areas. This type of knowledge can be described as <u>what</u> an individual knows. On the other hand, skills knowledge consists of the procedures, algorithms, and activities an individual is able to perform (e.g., solving math problems and playing tennis). Skills knowledge can be thought of as those things an individual knows <u>how</u> to do. Using this basic scheme of content and skills knowledge, four general categories of transfer can be identified--content to content, skills to skills, content to skills, and skills to content (these four types of transfer and associated examples are presented in Figure 3). Within each of these categories the difficulty of transfer will be strongly influenced by the compatibility of the individual's knowledge structure with the characteristics of the transfer task. A high degree of compatibility or similarity will imply "near" transfer, while a low degree will imply "far" transfer. (For further delineation of important dimensions of transfer see Royer, 1979).

In subsequent sections the research findings related to each of the transfer categories will be presented. Finally, the paper will conclude with a presentation of the implications of this body of research for educational practices in general and for the education of the hearing impaired in particular.

SECTION II: CONTENT TO CONTENT TRANSFER

The type of transfer to be discussed in this section involves the impact of content knowledge learned in one situation on the subsequent acquisition of new content knowledge. In an educational setting this typically would consist of transfer of knowledge from one course to the next. For example, prerequisite courses are assumed to provide the learner with basic knowledge that will facilitate learning in advanced courses. This facilitation may occur in a number of ways: The "old" content knowledge may provide a general framework for embedding the more detailed "new" knowledge, the "old" knowledge may consist of facts that can flesh out a "new" framework, or the "old" knowledge may provide a convenient analogy which can guide the acquisition of the "new" knowledge.

In this section the results of traditional studies of transfer with word lists will be briefly discussed. This will be followed by a review of the research on the retention and transfer of meaningful verbal learning; task, instructional and learner variables will be discussed separately. The section will conclude with a summary of the educationally relevant principles emerging from this body of research.

Studies of Transfer Using Word Lists

The literature on learning lists of paired associates is replete with transfer studies. The primary focus of these studies has been the effects of similarity between the original and transfer lists on performance with the transfer list (for a review of the relevant literature see Postman, 1971). Numer-

ous theoretical attempts have been made to provide a comprehensive account of transfer in terms of combined effects of stimulus and response similarity (e.g., Houston, 1964, 1966; Osgood, 1949). Although these attempts, particularly that of Osgood, have helped to summarize some transfer effects and to stimulate research, they have met with limited success. The principal difficulty encountered is that transfer, even with simple paired associate lists, is affected by many variables other than similarity. These difficulties are magnified even further when one considers using meaningful materials (e.g., descriptive texts) similar to those encountered in educational environments. As pointed out by Thorndyke (1977) in describing his research: "(The use of meaningful texts) has necessitated the definition of more complex relationships between training and target (transfer) materials, and a more [illegible] characterization of what a subject has learned than is customary in traditional verbal learning experiments" (p. 9[illegible]). The relative sterility of the paired associate and serial tasks makes it virtually impossible to draw any useful conclusions about educational practices. Consequently, in subsequent sections the emphasis will be on the retention and transfer of complex, meaningful material.

<u>Retention and Transfer of Meaningful Verbal Learning: Task and Instructional Variables</u>

Meaningful verbal learning typically implies the learning of text material (connected discourse). Since direct studies of transfer are relatively sparse in this domain, studies of

text retention will also be included in this review, the rationale being that retention of the original learning is a necessary condition for effective transfer. Consequently, it can be generally expected that tasks and instructional manipulations that lead to good retention may also lead to good transfer. However, it should be noted that good retention is not sufficient for transfer, and, further, the way the information is retained (e.g., how it is organized in memory) may be just as important as the amount retained. With these disclaimers in mind the salient literature will be presented under four subsections related to manipulations of content, organization, supplementary material and instructional methods.

Content. Instructional materials can vary with respect to comprehensibility (readability), familiarity, and concreteness. The large body of research on the readability of text has been extensively reviewed by Klare (1963) and Carroll (Note 1). Most of the published readability formulae involve objective measures of vocabulary and syntax. One notable exception to this is the cloze technique (Taylor, 1953). In this technique every nth word is deleted and a group of subjects at a particular reading level is asked to fill in the deleted words. The average number of words correctly filled in is used as the index of readability; the greater the number of correct words generated, the more readable the text. Bormuth (1966) claims that using this measure in conjunction with other readability formulae produces multiple correlation coefficients with measures of comprehension and retention of between .85 and .95. Given

this level of predictability, it seems very reasonable for educators to select or create instructional materials that have a high degree of readability as measured by these techniques.

With regard to the familiarity of the content, a substantial amount of recent research under the rubric of schema theory has suggested that the amount and form of the relevant background knowledge an individual brings to the instructional setting strongly influence what and how much is learned from the instructional materials (for reviews of this research, see Munro & Rigney, 1977 and Anderson, Spiro & Anderson, 1977). It appears as if text information is interpreted, organized, and retrieved in terms of high-level schemata or systems of placeholders. It follows that the student who does not possess relevant schemata is going to have trouble learning and remembering the information encountered in stories and textbooks. There are a number of things educators can do to alleviate this problem. As Thorndyke (1977) suggests:

> One might, for example, teach a subject domain in a top-down hierarchical fashion, by making explicit during initial exposures the general form or structural characteristics of the material to be presented, and by gradually increasing the degree of detail and specificity. Thus, initial learning would consist of acquisition of the appropriate general structure (schema), while subsequent learning would require the acquisition of detailed facts to fill out the overall organizational framework. This presentation strategy has been termed "web teaching" (Norman, 1973). (p. 97).

In addition to assisting the student in establishing relevant schemata, the instructor can facilitate the activation of already existing schemata by providing appropriate cues and bridging materials. A discussion of these forms of advance organizers will be presented under the section entitled Supplementary Materials.

Instructional content can also vary in terms of concreteness. Many studies of paired associate learning have demonstrated that concrete words in lists of paired associates are learned faster than abstract words, and that picture pairs are learned faster than their corresponding word pairs (Paivio, 1971). These findings of superior recall of imageable material has been extended to prose. Montague and Carter (1973) obtained superior immediate recall of more vivid (concrete) passages than of less vivid passages by college students. Johnson (1974) found that idea units rated high on concreteness were recalled better both immediately and after a seven-day delay and that there was no interaction of concreteness and retention interval. Further, Royer and Cable (1974) have shown that concrete, easily understood material leads to positive transfer in the learning of more difficult, abstract material.

Despite the generous use of pictures and illustrations in textbooks, little systematic study of the interactive effects of pictures and text on learning and retention has been conducted Dwyer (1967) found an advantage of abstract, schematic line drawings in the teaching of anatomy, whereas realistic pictures were no better than strictly verbal presentations. Fredrick

(Note 2) found students learned grammatical principles better from symbolic representations (tree diagrams of syntactical representations) than from verbal statements. Stromnes and Nyman (1974) found superior recall of information at both immediate and one year intervals from a passage supported by a picture than from the same passage without a picture. Although the research indicates pictures do seem to help, further studies are needed to determine what kinds of pictorial representations enhance the transmission of information, and under what circumstances.

Given the data cited above, it is clear that educators should attempt to select or develop concrete instructional materials that are liberally supported by pictures and illustrations and, where possible, to use such materials as precursors to learning more complex, abstract information.

Organization (Structure). Instructional materials must be presented in some sequence, and indeed this is usually one of the first problems instructors encounter when planning a course of instruction. The problem the instructor faces is that most bodies of information are not clearly organized into a simple sequence. Rather, there are interlocking relationships such that any concept must be considered in relation to several others. Yet language permits the statement of such relationships only one at a time; consequently, a decision must be made as to which relationship is stated first, second, and so on.

After an extensive review of the literature, Dansereau, Evans, Wright, Long, and Actkinson (1974) reached three con-

clusions regarding the sequencing of material. First, although the results are mixed, there is apparently an effect of sequencing on comprehension and retention of academic-like material. Second, except for very specific types of material, there have been very few techniques developed which would provide optimal or near optimal sequences. Third, the lack of attention to individual differences in academic aptitude has undoubtedly led to the masking of sequencing effects.

On the basis of these conclusions it is clear that further effort should be directed toward the development of technologies for generating sequences and subsequent assessments of the effectiveness of these generated sequences with different bodies of material and with students differing in academic aptitude. As a first step in this direction, Dansereau, Long, Evans, and Actkinson (1980) used multidimensional scaling (MDS) as a methodology for creating a composite organizational structure of a set of concepts using the similarity judgements of a number of experts. Systematic algorithms were then employed for sequencing the concepts. The results of this study were promising in that MDS-generated instructional sequences led to higher levels of performance in the learning of technical information.

Along a similar line, there have been a number of attempts to develop procedures for specifying the structure of existing texts. These attempts fall under the rubric of text grammars (Meyer, 1975; Rumelhart, 1975; Van Dijk & Kintsch, 1977). Results of experiments using text grammars to specify relation-

ships have indicated that superordinate propositions (those appearing at high levels in the text hierarchy) are better retained, especially at increased retention intervals, than subordinate propositions (these are defined as propositions whose arguments had previously occurred in other propositions). (See Kintsch, Kosminsky, Streby, McKoon, & Keenan, 1975; Meyer, 1975). Also, Thorndyke (1977) has shown that presenting two successive text passages with the same structure and differnt content leads to improved learning of the second passage. Apparently the structure acquired by the student from the first passage facilitates the learning of the new information in the second passage.

One educational implication arising from the research on organization and structure is that multi-dimensional scaling, as well as other forms of specifying relationships between concepts, may be potentially useful in developing optimal instructional sequences. A second implication, based on the work of Thorndyke (1977), is that the structures of text material should be standardized as much as possible and, where practical, the nature of such structures should be brought to the attention of the students. This latter point will be expanded in a subsequent section on learner variables.

Supplementary Materials. In addition to the primary instructional materials, a number of types of supplementary materials have been proposed as potential aids to learning, retention, and transfer. These include advance organizers, behavioral objectives and inserted questions. Ausubel (1963,

1968) proposed that a reader's abstract cognitive structures provide the "ideational scaffolding" for the detailed information contained in text. In his words (1968, p. 153), "...new ideas and information are learned and retained most efficiently when inclusive and specifically relevant ideas are already available in cognitive structure to serve a subsuming role or to furnish ideational anchorage." In line with this theoretical perspective, Ausubel has proposed the concept of advance organizers. According to Ausubel (1978), advance organizers are introductory material at a higher level of abstraction, generality, and inclusiveness than the learning passage itself and are relateable to presumed ideational content in the learner's current cognitive structure. In some ways advance organizers can be thought of as attempts at "bridging" the gap between a learner's prior knowledge and the present learning materials. To date, the research on advance organizers has been somewhat equivocal. Some studies have obtained positive effects (e.g., Mayer, 1976) and others have found no differences due to organizers (e.g., DeCaro, 1977). For reviews and discussions of this research see Barnes and Clawson (1975), Hartley and Davis (1976), Lawton and Wanska (1977), Ausubel (1978), and Mayer (1979). The root of this equivocality seems to be the vagueness of the definition of advance organizers. There are no specified rules for constructing these types of materials. Consequently, their potential effectiveness varies with the cleverness of the instructional designer. Given this situation, the existence of a number of published reports on the positive

impact of advance organizers coupled with the lack of direct negative effects (see the above-mentioned reviews for examples) provides support for the efficacy of this approach. Of particular importance for transfer is the work of Mayer (1976). He found that subjects given an advance organizer in the form of pretraining with a concrete model of the computer before learning performed better on novel (far) transfer and about the same on near transfer relative to no-pretraining subjects, including subjects who were given posttraining with the same model after learning. He suggests that the concrete model served as an advance organizer which provided subjects with a meaningful learning set to which new information could be assimilated. Those subjects who did not receive the model were apparently encouraged to build narrower outcomes by adding the new technical information to their memories in the form presented. The import of Mayer's study is that advance organizer material may be effective in promoting delayed retention and far transfer, and consequently should be used in settings where these effects are desirable. In another study, Mayer (1978) found that low ability subjects given an organizer prior to reading performed better on questions that required integrating across different paragraphs of the presented text, and subjects given the organizer after reading performed relatively better on questions concerning information that they had read within the same paragraph. Apparently the advance organizer used in this study served as an integrating context to which new, incoming information could be assimilated. When the test

questions reflect the presentation organization, an advance organizer apparently has little positive effect; however, when the material is presented in an order that is inconsistent with the posttest questions, then advance organizers seem to have a facilitative effect. Since this latter situation is more likely to arise in most real world educational settings, it seems highly advisable for educators to devote considerable effort to the development of appropriate advance organizers. According to Ausubel's (1968) subsumption theory and Mayer's (1975) assimilation encoding theory, advance organizers may be especial: important for the learning of technical, unfamiliar, or poorly organized material because they serve the following functions: (a) availability--a meaningful context is provided to which new material may be assimilated. For example, Ausubel (1968, p. 148 has argued that meaningful learning requires having relevant "ideas already available in cognitive structure" and for advance organizers to provide these "anchoring ideas or subsumers", the advance organizer must be "presented at a higher level of abstraction, generality, or inclusiveness." (b) Activation--advance organizers may serve to encourage an encoding strategy in which the learner attempts to integrate incoming information with the meaningful context. In this regard, Ausubel and Fitzgerald (1961, p. 266) have used the term "discriminability" to refer to the role of an organizer to "delineate clearly, precisely, and explicitly the principal similarities and differences between the new learning passage...and existing related concepts in cognitive structure." Ausubel (1968) and

his colleagues (Ausubel & Fitzgerald, 1961) have suggested using an "expository organizer" when no anchoring ideas are available to the learner and using a "comparative organizer" when anchoring ideas are available.

The concept of advance organizers can be thought of as a subset of a broader, more basic theoretical framework labeled "schema" theory. Schemata are abstract knowledge structures whose elements are other schemata and slots, placeholders, or variables which can take on a restricted range of values (Minsky, 1975; Rumelhart & Ortony, 1977; Schank & Abelson, 1975). A schema is structured in the sense that it indicates typical relationships among component elements. In the simplest case the reader or listener will have a preformed schema adequate to subsume (Ausubel, 1963) a text. The encoded representation of such a text will consist of the subsuming schema in which the slots have been assigned specific values; that is, are instantiated (Anderson, Pichert, Goetz, Schallert, Stevens, & Trollip, 1976) with the particular information in the message. A person will have the subjective sense that a passage has been comprehended when there is a good match between the information presented and the slots in the schema.

The learner uses two general kinds of schemata in interpreting text. The first embodies knowledge of discourse conventions that signal organization. These are probably specialized conventions characteristic of distinct text forms as well as conventions common to most forms; thus, it is possible to speak of a story schema, a personal letter schema, a news

article schema, a scientific report schema, and so on. As a class, knowledge of the discourse-level conventions of text may be called textual schema. Very little research has been conducted with these types of schemata; one notable exception which will be taken up in a later section is a recent study by Brooks and Dansereau (1980).

The majority of prior research has been concerned with a second general type of schemata, namely content schemata, embodying the learner's existing knowledge of real and imaginary worlds. What the learner already knows and believes about a topic helps to structure the interpretation of new messages about this topic. A variety of experimental techniques has been employed to study the effects of schemata. For instance, titles have been provided that induce different interpretations of ambiguous passages (Bransford & Johnson, 1973; Schallert, 1976) Or, characters in the passage to be read have been assigned the names of well-known figures, thereby insinuating the relevance of the learner's existing knowledge of these individuals (Sulin & Dooling, 1974; Brown, Smiley, Day, Townsend, & Lawton, 1977). Or alternate introductions to the passages have been written so as to cause learners to identify with different characters (Owens, Dafoe, & Bower, 1979). Or, schemata have been manipulated by selecting subjects with different amounts of knowledge about a topic or different cultural backgrounds (Anderson, Reynolds, Schallert, & Goetz, 1977; Spillich, Vesonder, Chiesl, & Voss, 1979; Steffenson, Jogdeo, & Anderson, 1978).

Two clear findings have emerged from this research. First,

learners make inferences consitent with their schemata. Second, they recall more text information important to their schemata. Although this research has been useful in demonstrating the importance of the interaction of an individual's memory structure with the text to be learned, the focus of this research has been almost exclusively on narrative discourse (i.e., stories). This is unfortunate in that the type of schema that are useful in understanding and recalling narrative prose may not be directly generalizable to many types of academic materials where the individual does not have a stored set of directly relevant experiences. In these situations it would appear that more abstract or textual schemata would be of greater importance. In particular, the processing of academic material should be facilitated by form schemata which specify the set of categories of information a well-informed learner should know about a particular topic. Unfortunately very little research has been directed toward this aspect of schema theory. The one study in this domain, Brooks and Dansereau (Note 3), will be discussed in a subsequent section.

Behavioral objectives are another type of supplementary material that have been used to promote learning, retention and transfer. These are statements provided to the learner about what should be achieved as a result of the learning experience. Those such as Gagne (1967), Glaser (1967), and Mager (1968) who support the use of behavioral objectives typically claim that behavioral objectives clearly indicate to students what is required of them, and as a result relevant

learning is enhanced. Those such as Atkin (1968), Eisner (1967) and Raths (1971) who express reservations about behavioral objectives suggest that they discourage students from expanding their horizons by encouraging them to confine their learning to specified objectives, and as a result incidental learning is depressed. Unfortunately, much of the dialogue concerning the strengths and weaknesses of behavioral objectives fails to distinguish between hypothetical claims and empirically substantiated knowledge. Melton (1978), in a review of the literature, concludes the following: "From this review it is clear that a variety of complex conditions determine whether or not behavioral objectives enhance relevant learning and depress or enhance incidental learning...Much effort has been wasted in attempting to find a simple, universal answer as to whether behavioral objectives should or should not be used, and an alternative approach is required. It is suggested that this should be one that treats behavioral objectives simply as one of several tools available to educators, with research directed toward determining not only their advantages and limitations, but also the conditions under which they can be used most effectively." (p. 299). Given the uncertain state of the research findings concerning behavioral objectives it is difficult (at this time) to make a positive or negative recommendation concerning their implementation in educational settings.

Adjunct questions are conceptually related to behavioral objectives but have received substantially more research atten-

tion. Typically, one or two adjunct questions are inserted either before (prequestions) or after (postquestions) a segment of text. After reading the passage, examination is then made of the amount of questioned (intentional) and nonquestioned (incidental) passage material retained by the learners. The typical finding in studies of this sort (see Anderson & Biddle, 1975, and Rickards, 1979, for reviews) is that the prequestion group retains roughly the same amount of material directly questioned as the postquestion group, and that both adjunct question groups retain more of the questioned material than a reading-only control group. This has been called the "direct instructive effect" (Rothkopf, 1966). More important, adjunct question studies have generally demonstrated that a postquestion group produces more recall of material not actually questioned than a prequestion group or a reading-only control condition. It is this so-called "mathemagenic" (Rothkopf, 1965) effect or "indirect effect" (Anderson & Biddle, 1975) which has received the greater degree of empirical attention (see Hartley & Davies, 1976, and Rickards & Denner, 1978, for reviews).

Of particular importance in this domain is the research on the use of different types of adjunct questions. Table 1 (from Andre, 1979) illustrates the major types that have been explored. Andre (1979), in an extensive review of this literature, concludes that higher level questions (those above the factual level, see Table 1) have facilitative effects on both reproductive and productive knowledge, but that the conditions under which such facilitation occurs are not well understood.

With regard to transfer, a number of studies suggest that when students are given adjunct application questions (see Table 1) about concepts and principles, as compared to adjunct factual questions, their ability to use knowledge of the concepts and principles to recognize new examples or solve problems involving the concepts and principles is enhanced (Watts & Anderson, 1971; Dapra & Felker, Note 4). The effects of the questions appear to be specific to the concepts and principles asked about in the adjunct questions; the acquisition of other concepts and principles discussed is not facilitated (Shavelson, Berliner, Ravitch, & Loeding, 1974; McKonkie, Rainer, & Wilson, 1973).

There are also a number of additional studies using high level questions that appear to have direct educational implications. For example, Anderson, Anderson, Dalgaard, Paden, Biddle, Surber, & Alessi (197[illegible]) found that cognitively high level adjunct questions significantly enhanced performance in an economics course when presented as part of a computer assisted instruction program. Moreover, research by Rickards and Hatcher (1978) has demonstrated that the insertion of high level adjunct questions significantly enhanced the performance of poor "comprehenders," i.e., readers whose vocabulary level was average or above, but whose comprehension subtest score in a reading achievement test was one year or more below average. Given this information, applied researchers might well further explore the use of adjunct questions in computer assisted instruction settings or, perhaps, as a remedial reading technique employing a transfer of learning design.

In summary, the results of the adjunct question studies strongly indicate that high level post questions be included with primary instructional materials.

Instructional Methods. A large variety of instructional methods has been implemented and assessed (e.g., programmed learning, computer assisted instruction, lecture, discussions). Unfortunately the results of these assessments have been largely equivocal. Dubin & Taveggia (1968) in an extensive review of the educational literature, conclude that there appears to be no difference among truly distinctive methods of college instruction when evaluated by student performance on final examinations. More specific instances of this equivocality have been pointed out by Carroll (Note 1) and Dansereau (1978).

Most of the studies assessing instructional methods have not looked at the interaction of instructional methods with other variables such as individual differences and type of assessment. This is unfortunate in that the few studies examining interactions have produced some interesting results. For example, it has been typically found that discovery (trial and error) learning methods produce better "far" transfer to novel situations while expository (guided) learning methods produce better "near" transfer (Mayer, 1975). Further, with regard to individual difference interactions, it has been found that field independent individuals (those who can locate a simple figure in a more complex field) benefit more from discovery learning situations while field dependent individuals (those who have difficulty locating simple figures within more complex ones)

benefit more from expository or guided learning conditions (McLeod & Adams, 1979). Clearly, these types of interactions would seem to mask main effects in studies that did not include these additional variables.

The evidence from the research on different instructional methods would suggest that an omnibus approach to instruction is ill-advised. Rather, instructional methods should be tailored to fit the desired learning outcomes and the individual aptitudes, styles, and preferences of the learners. Further information on approaches to matching instruction to individual differences has been provided by Hunt (1977) and Snow, Shuell, and Marshalek (Note 5). This topic area will be elaborated in the next section.

Retention and Transfer of Meaningful Verbal Learning: Learner Variables

This section contains a presentation of a variety of individual difference variables that have been related to learning outcomes. Where appropriate the potential interaction of these variables with instructional and task variables will be discussed.

Intellectual factors. One important intellectual factor is conceptual or integrative complexity. This factor is defined as: "The extent to which dimensional units of information can be interrelated in different ways in order to generate new and discrepant perspectives about stimuli" (Schroder, Driver, & Streufert, 1967, p. 25). This aptitude or capacity has been measured by a variety of techniques. For example, subjects are

asked to complete a passage on some academic topic. Expert raters then analyze the subject's output for the following type of evidence: inability to generate conflict or diversity, inability to view a situation from another person's point of view and see it in relation to one's own, inability to generate alternate perceptions and outcomes, tendency to seek structure, avoid delay, to close fast, etc. Persons with the above tendencies are rated "concrete" or "simple"; persons with opposite tendencies are rated "abstract" or "complex."

Schroder, Driver, and Streufert (1967) have also measured conceptual complexity in a multidimensional scaling task. In this situation a multivariate technique is used to abstract a subject's conceptual space from his similarity judgments of all possible pairs of stimuli (for example, semantic concepts). The more a conceptual space contains dimensions of information that are not objectively or directly given by the situation, the more "abstract" or "complex" the individual. The "concrete" or "simple" person is considered to be more "stimulus bound." Also, according to the above authors, more balanced use of dimensions indicates a more "abstract" individual.

In tactical simulation games, conceptually complex people apparently develop higher level strategies than simple persons no matter what the level of environmental complexity (Streufert, Clardy, Driver, Karlins, Schroder, & Suedfeld, 1965; and Driver, Note 6).

Claunch (1964) compared the examination performance of "concrete" (simple) and "abstract" (Complex) students (holding

Scholastic Aptitude Test scores constant) in an introductory course on personality. On objective questions, "abstract" and "concrete" individuals scored equally well, while on essay questions, "abstract" persons performed at a significantly higher level.

Along a similar line, Suedfeld and Hagen (1966) showed that high conceptual level subjects were better than conceptually simple subjects at solving complex verbal problems, but not at solving simple ones.

"Complex" and "simple" individuals were asked to identify an indistinct or unstructured stimulus pattern and their predecision information processes were assessed. Structurally complex Ss generated more alternative responses and made greater differentiating, encoding, and inferring responses (Sieber & Lanzetta, 1966; Saloman, Note 7).

Conceptual complexity, which exhibits correlations ranging from .12 to .50 with IQ, appears to be a potentially potent factor in determining the types of learning and problem solving strategies which can effectively be used by an individual. Obviously, learning methods requiring rapid integration of a diverse set of materials would be extremely difficult for a conceptually "simple" individual to employ. Conversely, "complex" students may become bored with simple tasks and strategies.

The Structure of Intellect model (Guilford & Hoepfner, 197 provides a good framework for discussing component learning skills. In this model, five intellectual "operations" have

been identified by factor analysis of a large variety of paper and pencil tasks. These operations and their corresponding descriptions are as follows:

(a) Cognition -- Immediate discovery, awareness, rediscovery, or recognition of information in its various forms, comprehension or understanding.

(b) Memory -- Fixation of newly gained information in storage.

(c) Divergent production -- Generation of logical alternatives from given information, where emphasis is upon variety and quantity.

(d) Convergent production -- Generation of logical conclusions from given information, where emphasis is upon achieving unique or conventionally best outcomes.

(e) Evaluation -- Comparisons of items of information in terms of variables and making judgments concerning criterion satisfaction.

Prior empirical work has shown that ability to perform the Structure of Intellect operations strongly relates to achievement in ninth grade math (Guilford, Hoepfner, & Peterson, 1965; and Guilford & Hoepfner, 1971), tenth grade geometry (Caldwell, Schroder, Michael, & Meyers, 1970), advanced calculus (Hills, 1957), and concept learning (Dunham, Guilford & Hoepfner, 1968).

In a more general sense it should be noted that intellectual aptitude of the learners may strongly influence the apparent effectiveness of various instructional methods. For example,

Snow (1977) suggests the following:

> ...in conventional lecture-demonstration instruction in science, one will usually find a moderate correlation between mental ability at the start and achievement at the end. If one makes the instruction more inquiry-oriented, the ability-achievement correlation will usually go up. That is, higher ability students do better and lower ability students do less well, relative to conventional conditions. If, on the other hand, the instruction makes increased use of physical models and simplified, clear-cut demonstrations, the ability-achievement correlation may often go down; here, lower ability students do better and higher ability students do less well, relative to their performance in conventional conditions. This sort of result has led to the hypothesis that increasing the information processing burdens in instruction allows high [ability] students to capitalize on their ability, while overtaxing the lower ability students. Removing some of these burdens compensates for low [ability] students' weaknesses. In effect, the treatment must be made to do for these latter students what they cannot do for themselves, at least temporarily. This helps lower ability students but fails to stretch higher ability students and in the extreme bores them or interferes with their idiosyncratic processes. Such phenomena are ubiquitous in education, but they are not at all well understood. Obtaining such understanding requires process analyses of both aptitudes <u>and</u> instructional situations. (pp. 5-6).

Personality Variables. Rokeach (1960) implied that highly dogmatic learners (as measured by a paper and pencil test on dogmatism) would presumably reject new belief systems because of the threat such individuals associate with beliefs which differ from their existing cognitive systems. They, more than others, would probably avoid discrepant or novel information. On the other hand, low dogmatic learners would presumably experience no such threat and would, accordingly, be open to novel information. Experimentation on this issue has shown that high dogmatics make more errors than low dogmatics in learning "belief incongruent" associates (for example, ball-square) but excel in the acquisition of "belief congruent" pairs such as ball-round (Adams & Vidulich, 1962). Along similar lines, Kleck and Wheaton (1967) found that high dogmatics recalled less information which disagreed with their existing beliefs than low dogmatics.

The concept of Internal versus External control of reinforcement, introduced by Rotter (1966), refers to the degree of control the person judges that he/she has over his/her environment. The person at the "internal" end of the continuum perceives outcomes to be a consequence of his/her own actions. The person at the "external" pole believes that outcomes are due to fate, luck, and powerful others, and, therefore, are beyond his/her personal control. "Internals" more actively seek information relevant to problem solving than "externals" (Davis & Phares, 1967). "Internals" tend to retain more information when this information is relevant to personal goals (Seeman,

& Evans, 1962). And "Internals" tend to better utilize information that has been equivalently acquired and retained by internals and externals (Phares, 1968). Julian and Katz (1968) using a synonym/antonym word-pair identification task showed that "internals" spend more time on difficult items than on easy ones, while externals' decision times are not related to item difficulty.

In an extensive review, Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, and York (1966), found that sense of control over the environment was the best single predictor of Black students' academic achievement. It is interesting to note in this regard that Internal-External control is virtually unrelated to IQ (Hersch & Scheibe, 1967; Rotter, 1966).

Cognitive styles. Cognitive styles, in many cases, appear to mediate between personality characteristics and aptitudes on one hand, and concrete learning and problem solving strategies on the other. Cognitive styles have been defined by Witkin, Oltman, Cox, Ehrlichman, Hamm, & Ringler (Note 8) as: "Characteristic modes of functioning that we show throughout our perceptual and intellectual activities in a highly consistent and pervasive way (p. 2)," and by Kagan, Moss, and Sigel (1963) as: "Stable individual preferences in the mode of perceptual organization and conceptual categorization of the external environment (p. 74)." As can be seen from the above definitions, cognitive styles act more or less as meta-strategies, and as such create definite boundaries on the types of specific strategies available or potentially available to individuals. Examples of specific cognitive

styles and their relationship to educationally relevant variables will be presented next.

A number of studies (Gardner, 1953; Bruner, Goodnow, & Austin, 1956) have demonstrated that individuals tend to use relatively constant category widths in the classification of objects and events. Pettigrew (1958) developed a Category Width Scale which has been positively correlated with breadth of stimulus generalization (Wallach & Caron, 1959), and negatively related to the recall of human faces in an incidental learning task (Messick & Damarin, 1964). High scorers (large category width) make more accurate perceptual judgments under normal conditions but not under distracting conditions (Bieri, 1969).

Kagan, Moss, and Sigel (1963) have identified three style categories based on the subjects' grouping of common pictorial stimuli. In using a descriptive-analytic style the individual tends to prefer to split these environmental stimuli into discrete entities and to respond to them as separate units. When analytic individuals are required to group stimuli for purposes of categorization, they tend to base their groupings on objective attributes shared by all of the stimuli. The inferential-categorical style is typified by a grouping of the stimuli which are categorized together. The relational-contextual response is based on a preference by the subject toward categorizing stimuli on the basis of functional or thematic relationships which may occur among these objects.

Generally these last two categories are combined to form a

"non-analytic" category, thus producing a bi-categorical system: analytic style versus nonanalytic style. Sigel (1967) has constructed a paper and pencil test for tapping these two styles. Subjects who have been found to be analytic appear to attend to more factual detail in concept acquisition (Kagan et al., 1963), are superior to nonanalytics in learning concepts based on objective similarity of detail among visual stimuli (Lee, Kagan, & Rabson, 1963), and score higher on performance tests than verbal tests (Kagan, Rosman, Day, Albert, & Phillips, 1964). Conversely, nonanalytics score better on verbal tests than performance tests; learn functional relationships better than analytics; and tend to be more impulsive than analytics on tests of cognitive control (Kagan et al., 1963; Kagan et al., 1964). There does not, however, appear to be a significant difference between these two style categories in terms of IQ.

Beller (Note 9) has demonstrated that a specific teaching method can be designed to facilitate the learning of children in associating words with objects when the cognitive styles (analytic versus nonanalytic) of these children are identified and used to assign the children to teaching methods which are consonant with their stylistic preferences.

On the other side of the coin, Scott and Sigel (Note 10) showed that inquiry versus expository teaching methods used in grades 4, 5, and 6 actually influenced responses on the Sigel Cognitive Style Test (1967), thus indicating that the analytic-nonanalytic styles are somewhat modifiable.

The notion of field dependence and field independence was

originally developed by Witkin and his colleagues (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962; Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner, 1954). The Rod and Frame Test (RFT), in which the subject is required to directly or indirectly adjust a movable rod to the true vertical position while the rod itself is located in a separately tilted frame, and the Embedded Figures Test (EFT), in which the individual must detect simple geometrical figures contained within much more complex figures, have been used to assess field dependence. The more difficulty an individual has on the above two tasks the greater is his field dependence. Witkin and his colleagues (1967) have shown the invariance of the EFT and RFT scores under a variety of natural (for example, age, marriage, divorce) and experimental (for example, drugs, ECS, hypnosis) conditions.

Kennedy (1972) found that field independence (FI) was related to success in aviation training for both pilots and non-pilots. These findings are consistent with a number of other studies that reported superior performance by field independents on various pilot simulating, pilot related, or pilot selective tasks (Benfari & Vitale, 1965; Thornton et al., 1968; Barrett & Thornton, 1968; Crutchfield et al., 1958). In addition, engineers have been found to be more FI than a general college sample (Barrett & Thornton, 1967), while students majoring in liberal arts are more field dependent (FD) than those majoring in physics, math, and chemistry (DeRussey & Futch, 1971). It also appears that children with learning difficulties generally tend to be field dependent (Keogh &

Donlon, 1972; Bruininks, 1969; Stuart, 1967). Finally, Parasnis and Long (1979) found that hearing impaired students tend to be more field dependent than their normally hearing peers.

A few attempts have been made to match field dependent/independent styles with teaching method. Hester and Tagatz (1971) used a measure highly correlated with the EFT to assess analytic (FI) and global (FD) cognitive styles. They then instructed their Ss in two concept attainment strategies: "Commonality" (determining attributes common to correct instances) and "Conservative" (comparing negative and positive instances to find differences). Ss displaying analytic (FI) styles apparently could use either strategy effectively, while Ss displaying a global (FD) style were able to use the commonality strategy but not the conservative strategy. In another study, Grieve and Davis (1971) tested Analytic (FI) and Global (FD) subjects after 11 hours of geography using two methods of instruction (expository and discovery). They found Analytic (FI) Ss did generally better than Globals (FD) and that there was no aptitude treatment interaction. However, more recent studies have suggested that FIs learn more effectively with a discovery approach while FDs learn better with an expository approach (e.g., McLeod & Adams, 1979). More generally, research has indicated significant differences between field-dependent and field-independent individuals with regard to the teaching-learning process. As examples, field dependent individuals tend to be better at learning and remembering incidental social material (Eagle, Goldberger, & Breitman, 1969), are more affected

by external reinforcement in the form of praise or criticism (Ferrell, 1971; Konstadt & Forman, 1965), and are more likely to have difficulty with relatively unstructured material (Renzi, 1974) than field-independent individuals. Amplifying these ideas, Wittrock (1979) suggests that the field dependence/ independence dimension can be used as an index of the extent to which students will benefit from a structured vs. a more permissive environment. According to Wittrock, field-independent students learn better from a situation in which they are permitted to set their own goals, provide their own motivation, and determine their own reinforcement. Field-dependent students are more comfortable and learn better with externally defined goals, external reinforcement, and a clearly delineated structure.

Indirect evidence that instructional/communication approaches can be tailored to styles comes from studies in a therapeutic setting. Witkin, Lewis, and Weil (1968) found that therapists, regardless of their cognitive style, took a significantly more directive role with their field-dependent clients than with their field-independent clients. The therapists also tended to ask more questions answerable with a simple yes or no of their field-dependent clients, while asking more open-ended questions of their field-independent clients. The therapists thus seemed to be adjusting to the need for structuring based on their clients' cognitive styles. This adjustment seemed to take place automatically based on cues picked up in interaction with the client.

The results led Witkin, Moore, Goodenough, and Cox (Note 11)

to ask "whether by sensitizing teachers to the implications of their own styles and the styles of their students for the teaching-learning process, we may increase the adaptibility of teachers." (p. 50). A study by Doebler and Eicke (1979) attempted to partially answer this question with fifth-grade students. Teachers in the "experimental" schools were made aware of the educational implications of the field-dependence/independence dimension of cognitive style, the individual styles of their students and their own styles. Teachers in the "control" school received no information. Measures of self-concept and attitude toward school were administered prior to teacher training and again at the conclusion of the experiment to all students. Analyses of covariance indicated significantly higher posttest scores in the "experimental" schools on both the self-concept and attitude toward school measures.

The examples presented above provide clear evidence as to the relatively strong relationship between cognitive style variables and academic attitudes and behaviors. These styles or meta-strategies deserve even further consideration in the tailoring of instructional methods to individuals.

Reception preferences. At a somewhat more specific level than cognitive styles, individuals have preferences for receiving information in certain ways. As with styles, these preferences should influence the strategies available to a student and the effectiveness with which he/she applies them. Depending on their potency, these preferences will either limit which strategies can be taught to an individual or will themselves be modified

by strategy training procedures.

Hartnett (1973) assessed four dimensions of learning style preference in 2,175 Ss. These dimensions were:

(a) Preference for regular classwork versus independent study.

(b) Preference for objective versus essay examinations.

(c) Preference for lectures versus discussion.

(d) Like versus dislike of doing individual research.

As a result of this assessment study, Hartnett found the following:

On entering college, students generally preferred regular classwork, objective exams, discussions, and were equally divided on attitude toward individual research.

"Bright" entering students (as measured by Scholastic Aptitude Test scores and high school grade point averages) preferred regular classwork, objective exams, lectures, and individual research.

During the first two years of college, trends in preference generally were from assigned to independent study, objective exams to essay exams, discussion to lectures, and toward more individual research.

However, though there was a steady move toward preferences for less traditional styles during the first two years of college, it appeared to be the <u>less</u> able students whose learning style preferences were drifting in this direction. Although there were relationships between preferences and academic performances, it is not clear whether learning style preferences are a cause

or an effect of course grades. Obviously, further research on this issue is needed.

If learning style preference proves to be a viable educational variable, then matching of instruction to preference would probably be beneficial. If such matching is impossible or ineffective, perhaps the teaching of effective strategies for dealing with non-preferred instructional methods would enhance the achievement of "poor" students.

Closely related to learning style preference is a variable that has been labeled educational set by Siegel and Siegel (1965). The two extremes of educational set can be described as follows: A factually set learner is one who, by definition, is predisposed to learn factual content. He/she adds units of information to his/her cognitive structure without being driven to interrelate these elements into any conceptual whole. For such a learner, a fact has an integrity of its own. A conceptually set learner is one who, by definition, rejects factual acquisition except as units of information that are clustered and interrelated. He/she prefers to learn concepts and principles. When confronted by a bit of factual information he/she either dismisses it as "unimportant" or subsumes it under a broader conceptual framework.

Siegel and Siegel (1965) measured educational set by a forced choice inventory (Educational Set Scale) which required preference judgments. They showed that conceptually set learners exhibited higher performance on both conceptual and factual aspects of a final exam in a televised college course.

In addition, Sanders and Tzeng (1971) found evidence that preference for conceptual versus rote learning was related to actual performance on concept learning and rote learning tests in the predicted directions.

Based on these findings and intuitive grounds it seems reasonable to attempt to alter educational set in a conceptual direction. However, it is possible that by the time a student reaches college age, his/her educational set is relatively fixed and resistant to change. If this is the case, the present studies suggest the wisdom of arranging for congruence between the student's set and the educational goals imposed upon him/her.

Preferences for various types of media will potentially influence learning in ways analogous to cognitive style, learning style preferences and educational set. The actual effectiveness of various media in conveying information may reflect preference or the differential availability of effective acquisition strategies for different modes of presentation.

The hypothesis that adults generally have preferences for visual information is supported by Lordahl's (1961) finding that, in a concept discrimination task, subjects were more likely to attend to visual than to auditory stimuli. Also, Stevenson and Siegel (1969) found that as children get older, they pay increasing attention to visual information in film presentations and less attention to the auditory information.

James (1962) asked 503 basic airmen to express preferences for taking a lesson by reading or by lecture (a no-preference option was permitted). There were no performance differences

associated with preference but for the total sample learning by reading was superior to lecture. Preference was unrelated to ability, but the superiority of reading was greater for high-ability airmen.

In accord with the above study, at the high school level and beyond, research results usually favor reading over listening (Belcastro, 1966; Beighley, 1952; Cody, 1962). King (1968) and King and Madill (1968) found that with college stu ts reading and listening were about equally effective for retention of factual material, but that reading was superior for the comprehension of the "gist" or "theme." Research with nonprose verbal materials supports the idea that visual presentation is increasingly advantageous for more difficult material (Schultz & Kasschau, 1966; Van Mondfrans & Travers, 1964).

Combined auditory-visual presentation of connected prose either shows no advantage over visual presentation or actually constitutes an interference (Mowbray, 1953), particularly if the materials are easy.

Study behaviors and attitudes. A number of questionnaires have been developed to survey students' study habits (strategies) and attitudes (e.g., Brown & Holtzman, 1966, Biggs, 1970 a and b; Goldman & Warren, 1973). Experiments assessing the utility of these questionnaires have shown that behaviors delineated in this relatively economical fashion, do relate to academic performance, and in many cases, overshadow traditional ability measures. It seems clear that measures of this type should be administered in order to assist in the diagnosis of learning

difficulties. Once diagnosed, students can be given strategy training designed to ameliorate their specific problems. Approaches to this type of strategy training will be discussed in more detail in the section on skills to content transfer.

Summary of Educationally Relevant Principles

An examination of the research described in this section has led to the following suggestions for improving educational practices designed to foster content to content transfer:

1. Use existing readability formulas (see Carroll, 1971) to help select and/or create comprehensible instructional materials.

2. The general research on the facilitory effects of imagery would suggest that educators should attempt to select or develop concrete instructional materials that are liberally supported by pictures and illustrations and, where possible, to use such materials as precursors to learning more complex, abstract information.

3. Multidimensional scaling techniques and text grammar formulations should be used to provide a basis for organizing and sequencing instructional materials.

4. Make use of "web teaching" approaches (Norman, 1973). Teach a subject domain in a top-down hierarchical fashion by making explicit during initial exposures the general form or structural characteristics of the material to be presented (perhaps via overviews), and by gradually increasing the degree of detail and specificity.

5. Make sure individuals have appropriate prerequisite

information and create advance organizers to bridge the gaps between the student's existing cognitive structures and the target learning material. Both comparative and expository organizers (Ausubel, 1978) should be employed; these organizers should be made as concrete and as imagery evoking as possible.

6. High level adjunct post-questions (particularly application questions, see Table 1) should be used to facilitate transfer. These provide "forward" bridges to new materials. They also allow the instructor to assess the present state of the learner's knowledge as a basis for remediation. As illustrat in Figure 1, the learner's cognitive state is of critical importance as a prerequisite to subsequent transfer.

7. Less time consuming, guided, expository teaching methods should be used when the goal is "near" transfer, while discovery (trial and error) approaches (e.g., laboratory exercises) should be employed when "far" transfer is desired.

8. When feasible, instructional methods should be tailored to fit the styles, aptitudes, and preferences of identifiable subsets of learners. One salient example of the need for this type of tailoring is the finding that field independent students tend to learn better in a more permissive instructional environment, while field dependent students fare better with a more structured environment. Other important individual difference variables that should be considered in designing instructional methods are cognitive complexity, intellectual capabilities (e.g., structure of intellect dimensions), internal-external locus of control, and reception (learning) preference.

9. Individual differences in learning behaviors and attitudes should be assessed and used along with ability measures as a basis for assigning students to skills training programs. This suggestion will be amplified in a subsequent section on skills to content transfer.

SECTION III: SKILLS TO SKILLS TRANSFER

In this section the focus will be on the transfer of learned skills from one situation to another. Research relevant to cognitive and motor skills will be presented in separate subsections followed by a general section on important instructional variables.

Cognitive Skills

The term cognitive skills is used here to refer to those skills which involve primarily mental processes such as thinking and memory, and depend minimally on motor movement.

Learning skills. These skills are ones that facilitate the acquisition, retention, recall, and transfer of information. Rather than reviewing the relevant research at this time, a detailed discussion of learning skills will be presented in the section on skills to content transfer.

Problem solving and creativity. Skinner (1966) has defined a problem as a question for which there is at the moment no answer. This simple definition can be elaborated by categorizing problems into two major types: closed system problems and open system problems. Bartlett (1958) has suggested that closed system problems are formed in such a way that all the elements for solution are available, and what the problem solver has to do is fill in the appropriate element. In essence, closed system problems are characterized by the existence of an identifiable solution; further, progress towards this solution is usually also identifiable. Examples of closed system problems would include: anagrams, chess, logic and math problems

concept formation, equipment repair (trouble shooting), navigational problems, etc.

In open-system problems, the problem solver must go beyond the units immediately given in order to "close the gap." Neither the solutions nor progress toward solutions are easily identifiable with these types of problems. Examples of open system problems, which are usually stud[illegible] under the rubric of "creativity" would include: determining unusual uses for common objects, creating cartoon captions and movie titles, inventing a new device or product, writing a term paper, etc.

Most of the prior research with closed system problem solving has employed relatively artificial tasks (e.g., anagrams) and consequently the generality of most of the findings to real world problem solving is questionable. However, in the context of traditional concept formation studies in which a subject is asked to discover an experimenter-defined concept such as "one red circle," Bruner, Goodnow, and Austin (1956) have identified two basic strategies that may have some generality beyond this artificial task situation. The two strategies, scanning (partist strategy) and focusing (wholist strategy), are used by subjects in both "selection" (subject determines the sequence of examples to be examined) and "reception" (experimenter determines the sequence) paradigms. In the scanning (partist) strategy the subject selects a portion of a positive instance to entertain as his/her hypothesis and concentrates his/her efforts on proving this hypothesis correct. Because the subject needs to scan and remember only the part of each instance

that is relevant to his/her hypothesis, this approach is frequently employed by students. It does, however, have the disadvantage that the subject concentrates only on part of what he/she sees and is not likely to learn much while he/she is following a hypothesis that later proves to be wrong.

In the focusing strategy (wholist) the subject selects a positive instance, retains all aspects of it, and attempts to determine which attributes are irrelevant by comparing his/her retained positive instances to other positive instances. The differences between these two strategies may be clearer in the context of a literature review task. One could go through the recent issues of a likely journal and scan each article briefly (partist). Or one could, as soon as he/she came across a useful article, focus on it and then choose other articles in the light of the information obtained from this first positive instance (wholist).

Bourne (1963) and others have found the focusing or wholistic strategy to be more efficient in concept formation studies, but it is not always the most frequently used. Attempts at teaching college students this strategy in order to improve their concept formation performance have been successful (Klausmeier & Meinke, 1968). Perhaps such training would also lead to better performance in more real world tasks such as literature search and "trouble shooting."

Polya (1957) has developed a series of techniques or strategies which are applicable to problem solving in general. These techniques, called "heuristics," are "rules of thumb"

for decreasing the extent of an individual's search through his internal problem space. Two of Polya's heuristics, means-ends analysis and planning, have been incorporated into a computer simulated model of human problem solving. The General Problem Solver (GPS), as it is called, appears to emulate quite accurately human behavior on problems in logi (Newell, Simon, & Shaw, 1958). It has also been expanded by Ernst and Newell (1969) to solve a variety of other closed system problems.

GPS using means-ends analysis, begins to solve a problem by detecting a difference between the location of a desired goal state (that is, the answer) and the present location of the subject with respect to that goal. If there is no discrepancy, there is no problem. If, however, a discrepancy does exist, the exact nature of this discrepancy has to be determined and a suitable plan formulated to remove the discrepancy. If this plan cannot be formulated directly, GPS must first formulate some subgoal that can, in fact, be met. Thus, any problem is : rst analyzed to discover whether a discrepancy exists between "where an organism is now" and "where he/she would like to be." This analysis gives ri.e to a series of subgoals, each one of which may require formu.ation into further, less difficult subgoals. This hierarchy of subgoals is then attacked in order of difficulty-beginning with the most difficult and proceeding through to the least difficult. Once all subproblems have been solved, the solution of the original and major problem can take place.

In order to make this heuristic a bit more concrete,

consider the following example presented by Newell, Simon, and Shaw (1960): "I want to take my son to nursery school. What's the difference between what I have and what I want? One of distance. What changes distance? My automobile. My automobile won't work. What's needed to make it work? A new battery. What has new batteries? An auto repair shop. I want the repair shop to put in a new battery; but the shop doesn't know I need one. What's the difficulty? One of communication. What allows communication? A telephone...and so on."

In GPS an overall grasp of the problem is provided by the "planning" heuristic which consists primarily of changing an originally complex problem into simpler ones. This simplification is carried out by first abstracting the specific problem to more general terms, and then by simplifying the overall structure of the problem so that it can be subjected to a more direct means-ends analysis. Since the abstracting process serves to simplify the problem, this increases the likelihood that any proposed means-end solution will be successful. Solution steps generated at this level can then serve as plans or prototypes for steps to be taken with regard to the original, complex formulation of the problem.

Except for a few efforts in the concept formation domain, there have been virtually no systematic attempts at training general closed system problem solving techniques. Most problem solving training programs, some of which will be reviewed subsequently, have concentrated on training for creativity (open system problem solving). This situation should be remedied.

A good starting place for such programs would be to teach Polya's strategies and measure subsequent changes in closed system problem solving performance.

Generally, researchers have considered four stages of creativity (open system problem solving): preparation, incubation, insight, and verification. The preparation stage is typically restricted to a subject's attempt at understanding the problem through recall of his/her previous experience with similar problems, etc., (that is, the translation of the problem into an internal problem space). For our purposes this stage will be expanded to include the conscious production of potential solutions through operating on the problem space and preliminary judgments of the adequacy of produced solutions. In many cases, the steps contained within this preparation stage, which are analogous to those involved in closed system problem solving, are sufficient for production of an adequate solution. However, for various reasons, solutions generated at preparation stage may not be sufficient, and, in some cases, the remaining three steps may occur.

The incubation stage may consist of the unconscious production and judgment of solutions. Subjective reports of creative individuals (for example, Ghise in, 1952; Koestler, 1964) indicate that this incubation period may be facilitated by alterations in consciousness (sleep, reverie, drug-induced states, etc.). In fact, Green, Green, and Walters (Note 12) have drawn a series of inferences to support the notion that alteration of consciousness by brain wave training (bio-feedback) may potentially enhance

creativity. They note that many creative people report effective incubation and subsequent insight in states where visual imagery is enhanced (in addition, responses to a visual imagery questionnaire correlate .21 with responses to a creativity questionnaire, Schmeidler, 1965). Further, Green, Green, and Walters have shown that subjects trained to produce theta brain waves report concomitant increases in visual imagery. They thus conclude that such brain wave training would enhance creativity via enhanced visual imagery, and have embarked on a research program to assess this hypothesis. Perhaps direct attempts at training imagery ability, as well as other imagery enhancement techniques, such as mediation training, could be usefully employed in this regard.

At some point during the incubation period, the open system problem solver may experience "insight" or "illumination." An unconsciously produced solution has apparently passed some criterion of judged acceptability. Following insight, the problem solver will usually make some attempt to consciously verify or judge the newfound solution. Depending on the outcome of this verification, the problem may be solved or the problem solving process may be again initiated.

Certainly the greatest effort toward strategy training has been leveled at this creative process. Two studies are relevant to the training of students to prepare (problem translation primarily) for open system problem solving. Hyman (1961) asked engineers to study attempts already made to design a system for recognizing boxes in an automatic warehouse. One group studied

these previous attempts critically, in order to make up a list of faults; another group studied them constructively, in order to make a list of useful features. Later, when all subjects were asked to propose their own solutions to this problem, those who had studied constructively produced better solutions.

A parallel study by Torrance (1964) reached similar conclusions. He asked psychology students to read two articles in psychological journals, either critically or imaginatively, before the middle of the term. Then they had to develop an original idea, theory, or hypothesis and turn it in on the last day of the term. Again, the products of those who had read imaginatively received superior ratings for originality. Although these studies have some obvious flaws, they do contain potentially suggestive implications for education, and probably deserve careful replication and extension.

A number of attempts have been made to improve the quantity and quality of solutions produced in response to an open-ended problem. Most courses in brainstorming (for example, Osborn, 1953) attempt to increase quality and quantity by instructing participants to postpone criticism. Generally, it is assumed that criticism and harsh evaluation wil interfere with flexible idea production. Laboratory studies directed toward this issue have usually led to the conclusion that relaxed conditions and instructions not to evaluate produce more ideas and ideas that have a higher mean quality rating as judged by "experts" than those produced under more restrictive and evaluative conditions (Johnson, Parrott, & Stratton, 1968; Meadow, Parnes, & Reese,

1959; Dentler & Mackler, 1964; Gerlach, Schultz, Baker, & Mazer, 1964). However, at least some researchers have concluded that instructions to "produce more ideas and withhold judgment" lead to a greater number of ideas, but an overall mean decrease in quality (Weisskopf-Joelson & Eliseo, 1961). It is probably the case that these different results are due to differences between the subject populations.

Researchers attempting to evaluate the effect associated with the training of specific idea-producing techniques have focused on Allen's (1962) morphological synthesis approach. This technique requires analysis of the dimensions of the problem followed by a new synthesis. Ideas for improving one feature of the product are listed along one axis of a two-dimensional diagram and ideas for another feature are listed on another axis so that novel combinations appear at the intersections. In comparison to two other idea-generating techniques, Warren and Davis (1969) found increased productivity and more superior solutions with the morphological synthesis technique. Furthermore, this technique has been included in a large-scale training program for adolescents with apparently favorable results (Davis, Houtman, Warren, & Roweton, 1969).

Perhaps the most extensive attempt to include production training in an educational setting has been made by Crutchfield and his colleagues (Crutchfield, 1966; Covington, Crutchfield, Davies, & Olton, 1974). They have developed a programmed text for fifth and sixth graders which encourages the children to think about the complex materials presented and directs the reinforcement toward the production of

original and relevant ideas. In particular, the program is designed to instruct the student in the formulation of the problem, the asking of relevant questions, the laying out of a plan of attack, the generation of many ideas, the search for uncommon ideas, the transformation of the problem in new ways, the evaluation of hypotheses, and the openness to metaphorical and analogical hints leading to solutions.

A number of evaluation studies using open-ended problems (Crutchfield, 1966; Olton & Crutchfield, 1969) have found that students trained on the above method ask more questions, generate more ideas, and get higher ratings for creative quality than a matched control group. However, in a recent review of the literature, Mansfield, Busse, and Krepelka (1978) conclude that although some of the studies with this program provide evidence for its effectiveness, results obtained with tests dissimilar to the training materials (far transfer) have been inconsistent, so that it is unclear whether the effects are sufficiently generalizable to be useful in real-life situations. Mansfield et al. (1978), also reviewed a number of other creativity training programs and drew similar conclusions.

After a number of ideas have been produced, the open-ended problem solver must judge the solutions in order to provide a basis for selection. A few studies have emphasized this judgment process. These studies have provided "criteria-cued" instructions which spelled out the criteria to be used in evaluating the subject's productions and, in some cases, trained subjects on the use of these criteria. Generally, the

"criteria-cued" instructions result in reduced productivity compared to nonevaluative instructions, but also produced a higher average quality and a higher percentage of superior solutions (for example, Johnson, Parrot, & Stratton, 1968; Weisskopf-Joelson, & Eliseo, 1961; Gerlach, Schultz, Baker, & Mazer, 1964).

Stratton and Brown (1972) trained subjects on both morphological synthesis (production) and judgment criteria. Using responses to a request for titles based on a variety of movie plots, they found that the combined training produced solutions of higher mean quality than those with only production training and a larger number of solutions than those with only judgment training. This combined training approach offers some promise and should undergo further exploration.

Although the prognosis for far transfer of general problem solving and creativity skills does not appear to be very promising, it is possible that, if training on these skills were embedded in a particular technical area, transfer would be facilitated.

Motor Skills

The positive transfer of simple motor skills, such as those involved in the pursuit rotor tracking task, has been demonstrated in a number of studies (e.g., Holding, 1966). With respect to more complex motor skills, Duncan (1960), using a motor task analogous to verbal paired-associate learning (visual stimuli and motor responses were paired), showed that practice with one set of stimuli and responses would facilitate

transfer to other similar sets of stimuli and responses. This was particularly true when the original training was conducted over a variety of training tasks. These results are supported by another study (Russell, Note 13) which demonstrated that performance of a pencil-target task was also facilitated if subjects had previous experience with a variety of similar tasks.

Of particular interest are those few studies which indicate that transfer occurs for motor tasks that are both complex and have ecological validity. Pilot simulator research (Valverde, 1973), for example, has indicated that effective transfer occurs between mock-ups of both low and high similarity (far and near transfer) with actual flight. Singer (1977) in his review article has also reported studies by Prather (e.g., Berry, Prather, & Jones, 1971) which indicate that complex perceptual motor skills, such as range estimation used by airline pilots are transferable. Instructional variables that facilitate this and other types of skills to skills transfer will be discussed in the next subsection.

Instructional Variables

In this section instructional variables that potentially have impact on all types of skills to skills transfer will be discussed.

Discovery vs. guided instruction. Whether discovery learning (trial and error) or guided (prompted) learning leads to better transfer of skills has been an area of debate in instructional psychology for some time. Singer (1978) has reviewed motor skills research and has concluded that the method

of instruction given should be dependent on the type of transfer task and the amount of training time available.

A series of studies conducted by Prather (e.g., Berry, Prather, & Jones, 1971) compared trial and error learning to error-free learning in the training of complex perceptual-motor skills. In general, Prather has found that while prompted learning led to faster acquisition of skills, trial and error learning produced greater posttraining transfer. Also, Singer and Gaines (1975) have reported better transfer for a discovery method of instruction when a learning to criterion method is used. In addition, Egan and Greeno (1973) have found that discovery learning, as opposed to rote learning, leads to broader transfer in mathematics. Far transfer of problem solving strategies appears to be facilitated by a discovery method of instruction (Guthrie, 1967). Finally, Singer and Pease (1976), using three groups (discovery vs. prompted vs. discovery/prompted), found no difference in the amount of transfer between discovery and discovery/prompted learning, but did find that both of these instructional methods led to better transfer than prompted (guided) learning alone.

Contradictory studies in this area have been reported, however. For example, Macrae and Holding (1966) have suggested that prompted learning facilitates transfer on a complicated perceptual-motor task, and that trial and error learning leads to better transfer on simpler tasks. A later study by Singer and Pease (1976), on the other hand, found no interaction between task complexity and instructional method.

However, studies reporting positive effects of discovery learning transfer should be viewed with caution, since many times the tests used for measuring transfer are often similar to or the same as the discovery method training (Singer, 1977). Further, Singer and Pease (1976) have reported that when groups receiving discovery training are tested with a prompted learning task, they demonstrate less transfer than do groups who received prompted training. Many of these studies may, therefore, only be testing the efficacy of transfer across similar situations, and not the effectiveness of various modes of instruction.

Meaningfulness of instruction. Mayer (1975), in a series of experiments, has investigated the meaningfulness of instruction and its effects on transfer. The term meaningful is used here to refer to instruction which attempts to relate new information to the learner's previous experience and knowledge. one set of experiments (e.g., Mayer, 1974, Mayer & Greeno, 1972) students were taught the concept and application of binomial probability. Typically, these experiments used two groups. One group would be given meaningful instruction which emphasized relating previous experience to the learning of the binomial probability formula, while a second group was given instructions which consisted only of a formal statement of the rules for calculating binomial probabilities. Results from two experiments (Mayer, 1974; Mayer & Greeno, 1972) revealed that near transfer was facilitated by "rule" instructions, and that far transfer was facilitated by meaningful instruction. These findings are supported by Mayer, Stiehl & Greeno (1975) who found that students

who received pretraining in the general concepts of probability and combinations demonstrated better far transfer (or applications) of the binomial formula than students who did not receive pre-training.

It can be concluded from these studies that the transfer of skills is influenced by the degree to which they are integrated with a learner's prior knowledge. Related studies by Wittrock and Cook (1975), among others, support the general contention that transfer is facilitated when newly learned skills are spcifically related to a person's previous experience.

Instructions to integrate. Gagne's model (Gagne & White, 1978) of memory structures (Figure 2) leads to the prediction that skills learning which involves two or more memory structures (intellectual skills and propositions for example) would lead to both better retention and transfer of the acquired skills. In this regard, early studies on problem solving (e.g., Katona, 1940; Maier, 1930) generally support the contention that verbal statements of problem solving rules facilitated their retention and transfer. In addition, the previously mentioned studies by Mayer also support Gagne's view, since training subjects by a meaningful instructional method often involved the stating of rules (i.e., propositions).

Instructional methods involving images and episodes in learning and transfer of skills have also been the subject of investigation (Gagne & White, 1978). Those studies emphasizing the use of imagery generally show positive results. Research by Zimmerman and Rosenthal (e.g., Zimmerman & Rosenthal, 1974; Rosenthal, Moore, Dorfman, & Nelson, 1971) suggest that activa-

tion of both verbal and visual memory structures leads to better transfer than the use of either memory structure alone.

Studies involving more manipulative tasks (episodes), however, are more equivocal with only about half of the studies supporting an integration point of view. Studies by Bruner (1966), Sonstroem (1966), Dawson and Ruddell (1955), and Bledsoe, Purser, and Frantz (1974) have obtained positive results for the use of episodes (manipulative experiences) in learning, retnetion, and transfer. These studies, however, are counter-balanced by other research which has either reported neutral or contradictory results (e.g., Fennema, 1972; Passy, 1963; Trueblood, 1970).

Educational Implications of the Skills to Skills Transfer Research

By way of summarizing, the following instructional implications have been gleaned from the research on skills to skills transfer:

1. Open and closed system problem solving training courses should be developed and administered in close conjunction with a specific technical or academic domain. Since general training on problem solving skills has not proven successful in the past, the developers of problem solving courses should tailor the training to those skills required in a particular academic or technical area.

2. Discovery and meaningful learning should be emphasized in the classroom when broad generalization of skills is desired. Guided learning approaches can be employed when near transfer is the major goal.

3. In teaching skills, teachers should encourage the

student's use of various memory structures, such as imagery and verbal propositions, to increase the retention and transfer of skills. This type of manipulation should improve the integration of the learner's cognitive structure which should in turn improve subsequent transfer (see Figures 1 and 2).

SECTION IV: CONTENT TO SKILLS TRANSFER

This type of transfer occurs when an individual's prior knowledge influences the acquisition of a new skill. While content to skills transfer is probably involved in all skill learning situations, it has been the subject of a surprisingly small amount of research. In the area of perceptual-motor learning, at least, it has been argued by Marteniuk (1976) that the first step (e.g., the cognitive phase of motor learning) in executing a motor skill is to establish a plan or goal for performance and then collect pertinent information for achieving that goal. In other words, the most effective way to acquire a new skill is to possess relevant knowledge that will transfer to the learning of the new skill. This general theme is echoed by Fitts (Fitts & Posner, 1967) who states that it is during the cognitive phase of skill acquisition that the learner must form an idea or schema of the entire skill to be performed. Adams (1971) also promotes a similar view, suggesting that the early stages of motor learning are highly dependent on the verbal skills of the learner.

While these ideas have an obvious intuitive appeal for motor skills acquisition, it also seems reasonable that skill acquisition in a number of other areas would be facilitated if the learner could transfer appropriate content knowledge to the learning task. For example, Lave (1977) has demonstrated that one's general knowledge can affect problem solving skills. In this study, Liberian tailors varying in amount of tailoring experience and degree of education were asked to solve an arith-

metic problem which was presented in either a formal education or tailoring surface format. Transfer efficiency was significantly related to the content knowledge of the subjects. A relatively high degree of tailoring knowledge led to success across tailoring problems, and more experience with formal education led to transfer across school-formulated problems.

Several researchers have attempted to manipulate a learner's prerequisite knowledge relevant to acquiring a skill. Miyake & Norman (1979), have demonstrated that a person's knowledge of a specific content area greatly affects his/her use of a comprehension strategy such as questioning. Matching students, either trained or untrained, in operating a computer terminal with either easy- or hard-to-comprehend programming manuals, Norman found that untrained programmers tended to use a questioning strategy more often when instructed with the easy manual. Conversely, trained programmers tended to ask more questions when instructed with the hard manual. A general conclusion based on this study is that, in order to generate questions, a student needs to have some minimal amount of knowledge relevant to a topic available to him/her at the time of learning.

A number of studies by Mayer (1975; Mayer, Stiehl, & Greeno, 1975) have indicated that in general, meaningful and interpretative applications of problem solving skills are enhanced by instruction in content knowledge relevant to the transfer task. Specifically, Mayer, Stiehl, and Greeno (1975) found that preinstructional experience directly related to

arithmetic problems and varied in content (general knowledge and formula computation) facilitated skill learning under a meaningful instruction condition. In another study, Mayer (1975) had nonprogrammers learn a computer programming language through the use of a diagram model of the computer expressed in familiar terms or without the use of a model. In general, subjects in the model condition excelled on learning and transfer problems requiring interpretation, while nonmodel subjects did better on near transfer tasks requiring only generation of programs similar to those given in the instructions.

Along a similar line, Trollip (1979) used computer-assisted instruction (CAI) to train pilots in the skill of flying holding patterns. This training required the student to artificially "fly" a series of holding patterns at different levels of complexity. Students were given detailed pictorial and verbal feedback about their performance. Consequently, the student should be acquiring both knowledge and experience relevant to performing the required task. Students trained under this condition, when compared with traditionally trained students, demonstrated better performance in an evaluation flight. This suggests that the CAI-trained students could use their prior knowledge gained from feedback on their performance to facilitate their learning of actual flight skills. A final study in this area was conducted by Berg and Stone (1978). Testing whether modeling or verbal instructions were better for enhancing problem solving skills, they found that both methods of instruction and a combination of the two methods resulted

in superior performance on a problem solving task compared to a control group. These results support the notion that the prior content knowledge that a person has which is relevant to performing a skill will lead to more effective learning and use of that skill.

To briefly summarize, it appears that the prior content knowledge of a learner, if it is meaningful knowledge, functions similarly to Ausubel's (1963) advance organizer. That is, a person's prior knowledge serves as an "ideational scaffold" for the incorporation of new skills into the person's behavioral repertoire. Further, studies by Mayer and Greeno (Mayer, Stiehl, & Greeno, 1975; Mayer, 1975; Egan & Greeno, 1973) have given us some information on how different instructional methods interact with the prior knowledge of an individual in skill learning. In general, the basic conclusion of these studies is that those instructional techniques which emphasize meaningful learning are more effective for those students who already possess knowledge about the skill to be learned (typically an arithmetic problem). On the other hand, those students who lack prior knowledge about a skill tend to do better under more rote learning conditions. This type of interaction is typically obtained whether the learner's prior knowledge is acquired within the experimental manipulation (preinstruction), or is taken as a pre-experimental given.

The research reviewed in this section indicates that the following suggestions for improving educational practices should be considered:

1. In teaching a new skill, instructions should include content knowledge that is specific to the learning of that skill.

2. An attempt should be made to present new skills in a meaningful context if broad transfer effects are desired, while a more rote or algorithmic approach should be used if near transfer is the goal of instruction.

3. Knowledge relevant to acquiring a new skill should be presented without an excess of distracting stimuli. In other words, present a simple example of the skill and the context in which it is used before attempting to instruct the learner in more complicated aspects of the skill.

4. It should be a general practice to expose learners to varied types of knowledge about a skill to increase the effectiveness of transfer.

SECTION V: SKILLS TO CONTENT TRANSFER

This type of transfer involves the learning of skills that subsequently facilitate the acquisition, retention, retrieval, and transfer of knowledge. These types of skills or strategies are typically taught in separate study skills or learning strategies classes or workshops. In this section the prior research relevant to learning strategy instruction and training will be briefly reviewed. First, research exploring specific, isolated strategies will be discussed, followed by a review of studies of the effectiveness of larger strategy systems. The research in this general domain examines the types of content-independent knowledge discussed in conjunction with Figure 1 (see Section I: Introduction).

Manipulation of Specific Learning-Related Strategies

Most of the prior research on learning strategies has focused on assessing the effects on performance that result from isolated manipulations of component strategies. These studies have dealt with four primary strategy areas: identification, comprehension, retention, and retrieval; and one support strategy area: concentration. A brief overview of prior attempts to study each of these components follows.

Accurate identification of important, difficult, and unfamiliar material is necessary for appropriate allocation of students' time and energy. If such allocations are not accurate, then the resulting learning will be inefficient. In the past, the general approach to research in this area has

been to manipulate the identification and selection of stimulus material by varying anticipated recall requirements (Butterfield, Belmont, & Peltzman, 1971; Cermak, 1972; Jacoby, 1973) or monetary payoff conditions (McConkie, Rayner, & Mayer, Note 14; McConkie, Rayner, & Wilson, 1973). These studies do show that students can be flexible in their processing of incoming information, but the manipulations are so task-specific that they appear to have little applicability to strategy enhancement in general.

In the area of comprehension and retention, most of the attempts at improving students' skills have been indirect and have entailed stimulating the students to change their comprehension and retention activities with experimenter-generated pre, post, and interspersed questions (e.g., Frase, 1968; Mayer, 1975; Richards & DiVesta, 1974; Rothkopf & Bisbicos, 1967), pre- and postsupplementary organizing materials (e.g., Allen, 1970; Ausubel & Youssef, 1966; Frase, 1969; Gay, 1971; Scandura & Wells, 1967; Bauman & Glass, Note 15), and varying payoff conditions (McConkie & Meyer, 1974; McConkie & Rayner, 1974; McConkie et al., 1973). The findings of these studies generally indicate that the procedures had positive influences on the students' comprehension and retention strategies (see Dansereau et al., 1974, and the section on content to content transfer for a more thorough discussion of these studies). However, since these approaches require experimenter or teacher manipulations, they are not directly transferable to less controlled situations.

More direct manipulations of comprehension and retention strategies have been based on simply instructing (generally

without training) the student on a particular technique. Positive effects on performance have resulted from instructions to form mental images (pictures) of verbal materials (Anderson, 1970; Anderson & Hidde, 1971; Levine & Divine-Hawkins, 1974; Rasco, Tennyson, & Boutwell, 1975), instructions to state the material in the student's own words (DelGiorno, Jenkins, & Bausell, 1974), and instructions to reorganize the incoming material (DiVesta, Schultz, & Dangel, 1973; Frase, 1973). These instructional manipulations, although somewhat effective as they were first tried, could probably be enhanced by actual training and by integration with training on other aspects of the learning process.

There has been a dramatic upsurge of interest in mnemonic elaboration as a specific means for enhancing retention. Generally, mnemonic techniques involve embellishing the incoming material by creatively interrelating the items to be learned or by associating the items to a previously learned set of peg words or images (mental pictures). The following are some examples of mnemonic techniques:

First letter -- In order to remember the ordering of the 12 cranial nerves (olfactory, optic, oculomotor, trochlear, etc.) many of us have learned the phrase "On old Olympus' towering top a fat, agile German vaults and hops." The first letter of each word is also the first letter of each of the major cranial nerves.

Peg word -- A person first learns a rhymed peg word list

such as "one-bun, two-shoe, three-tree," and then learns to associate imaginatively each of these words with the members of a list to be learned. For example, in learning the items on a grocery list (e.g., steaks and potatoes) the student might first image bun and steak together as a sandwich, then potato and shoe as an Idaho potato in tennis shoes, etc. When asked to recall the second item on the list he/she locates the second pegword, shoe, and then recalls the image of the potato in tennis shoes.

Method of loci -- A learner mentally places items in distinct locations along a very familiar route (e.g., the route from the person's front door to the back bedroom). In order to recall the information, the student imagines traveling back through the route, picking up the items as they occur.

Many studies using lists of unrelated words and word pairs have shown that brief instructions on mnemonic techniques dramatically improve retention (Bower & Reitman, 1972; Danner & Taylor, 19 3; Groninger, 1971; Lo ry, 1974; Nelson & Archer, 1972; Santa, Ruskin, & Yio, 1973; Wanshura & Borkowski, 1974; Weinstein, 1975; Yuille & Catchpole, 1974). Although these mnemonic techniques have been successful with relatively artificial materials (nonsense syllables and unrelated words), very little effort has been made to apply these techniques to the more general problem of retaining connected discourse. (An important exception to this is the work of Weinstein, 1978).

Although the previously discussed approaches to strategy manipulation improve a student's ability to recall information,

they do so indirectly, by operating on the student's storage processes. More direct approaches are possible, involving retrieval plans for accessing stored materials that are not immediately available. These plans would most likely take the form of coherent search strategies similar to those used in solving problems that have well-defined solutions (e.g., chess problems often require the search for an optimal next move). The problem-solving strategies explored by Newell et al. (1958) provide a good starting place for the development of such techniques.

Unfortunately, very little work has been done in training students to use search strategies as aids to memory retrieval. The one exception is a study by Ritter, Kaprove, Fitch, and Flavell (1973), which attempted to improve children's recall performance by instructing them in what the researchers called "planful retrievals" (e.g., systematic search strategies). The results of this study indicated that the retrieval instructions helped, but the stimuli employed were so artificial (unrelated word pairs) that it is difficult to generalize the results to more meaningful tasks.

The last component to be considered in this section is concentration. Generally, attempts to improve concentration have been oriented toward teaching students to talk to themselves in a constructive, positive fashion as a means of coping with distractions and anxiety (Meichenbaum & Goodman, 1971; Meichenbaum & Turk, Note 16;Patterson & Mischel, 1975) or they have been oriented directly toward manipulating the student's

attention through behavior modification techniques (Alabiso, 1975). Both of these approaches have successfully increased the quantity of task-related behavior, but, unfortunately, they have not been coupled with strategies designed to increase the quality of such behavior (e.g., students may be trained to spend more time looking at a textbook, but additional training is probably needed to increase the quality and intensity of what they are doing while reading). Clearly this combination should be the ultimate target for a program designed to enhance learning skills.

In summary, the studies that have been reviewed to this point have suffered from at least two problems. First, the materials and tasks used to examine the manipulations have generally been highly artificial (e.g., serial and paired-associate lists of unrelated information). This artificiality limits the generality of these findings to educationally relevant situations. Second, specific components have been studied in isolation (i.e., they have not been integrated with training on other components of the learning process). This lack of integration is extremely troublesome in light of the obvious interrelationships between some of the components (e.g., enhancing comprehension-retention skills will clearly have an impact on retrieval, and vice versa). These interrelationships should enable a well-conceived, integrated program to have an impact greater than the sum of its individual parts. In the next section some of the prior attempts that have been made at developing such integrated training will be briefly examined.

Evaluations of Strategy Systems

Unfortunately, many of the reported learning strategies programs have nonempirical foundations, provide relatively superficial strategy training (usually only a subset of the essential learning concepts), are evaluated against nonspecific criteria (such as grade point average), and, consequently, lack specific evidence on which to base modifications.

The majority of these learning skills programs are based on the SQ3R approach proposed by Robinson (1946), or some slight modification of this approach. The five steps in the SQ3R technique require students first to survey the text chapter by reading headings, boldface type, etc. On the basis of the survey students are encouraged to develop questions. Then they read the material with an eye toward answering these questions. After reading, students are encouraged to close the book and recall what has been read. Finally, they open the book and review the material. Generally, SQ3R training is nonspecific; very little detailed information is provided on how to carry out the operations. It is assumed that the individual student is able to arrive at these more specific procedures without guidance. In light of the results with a learning strategy inventory (Dansereau et al., 1975a), this assumption is probably unwarranted; students appear to have little knowledge of alternative learning procedures, especially at a detailed level.

In any case, a number of programs of this type have been developed and shown to lead to improvement on measures of grade point average (Briggs, Tosi, & Morley, 1971; Whitehill, 1972)

and on self-report study-habit surveys (Bodden, Osterhouse, & Gelso, 1972; Brown, Webe, Zunker, & Haslam, 1971; Haslam & Brown, 1968; Van Zoost & Jackson, 1974). Although these programs probably benefit the student in a general way, the locus of the effects has not been determined. In addition to general measures of academic success, specific evaluations of learning performance should be made. Furthermore, these evaluations should be related to specific components of the programs to provide a basis for modification. However, even if the previously cited programs are successful, they could probably be improved by incorporating some of the more detailed strategies discussed in the previous section and by adding other strategies derived from the basic cognitive research literature on memory, comprehension, problem-solving, etc. The learning strategy training program to be discussed next was designed to overcome some of these criticisms.

A detailed description of the learning strategy training program developed at Texas Christian University is beyond the scope of this paper; the various portions of the system have been presented in a number of other technical reports and publications (Collins, Dansereau, Garland, Holley, & McDonald, 1981; Dansereau, 1978; Dansereau, Actkinson, Long, & McDonald, 1974; Dansereau, Collins, McDonald, Garland, Holley, Evans, & Diekhoff, 1978; Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979a; Dansereau, Long, McDonald, & Actkinson, 1975a; Dansereau, Long, McDonald, Actkinson, Ellis, Collins, Williams, & Evans, 1975b; Dansereau, Long, McDonald, Actkinson, Collins, Evans, Ellis, & Williams, 1975c; Dansereau, Long, McDonald,

Actkinson, Collins, Evans, Ellis, & Williams, 1975d; Dansereau, Long, McDonald, Actkinson, Collins, Evans, Ellis, & Williams, 1975e; Dansereau, McDonald, Collins, Garland, Holley, Diekhoff, & Evans, 1979b; Holley, Dansereau, McDonald, Garland, & Collins 1979), and the reader is referred to these documents for further information. In the remainder of this subsection a brief overview of this program will be presented.

The general approach to the development of this strategy system has been strongly influenced by the fact that effective interaction with technical material requires that the student actively engage in a complex system of interrelated activities. To assist the student in this endeavor, a set of mutually supportive strategies has been created. This set can be divided into "primary" strategies which are used to operate on the material directly and "support" strategies which are used to help the learner to maintain a suitable cognitive climate. The primary set includes strategies for acquiring and storing the information and strategies for subsequently outputting and using the stored information. Networking forms the basis for these primary strategies. During acquisition the student identifies important concepts or ideas in the material and represents their interrelationships in the form of a network map. To assist the student in this endeavor s/he is taught a set of named links that can be used to code the relationships between ideas. The networking processes emphasize the identification and representation of (a) hierarchies (type/part), (b) chains (lines of reasoning/temporal orderings/causal sequences), and (c) clusters

(characteristics/definitions/analogies). Figure 4 is a schematic representation of these three types of structures and their associated links and Figure 5 is an example of a summary map of a nursing textbook chapter. Application of this technique results in the production of structured two-dimensional maps. These cognitive networks provide the student with a spatial organization of the information contained in the original training materials. While constructing the map, the student is encouraged to paraphrase and/or draw pictorial representations of the important ideas and concepts for inclusion in the network.

When faced with a test or a task in which the learned information is to be used, the student is trained to use the named links as retrieval cues and the networking process as a method for organizing the material prior to responding. Assessments of networking (Holley et al., 1979; Dansereau et al., 1979b) have shown that students using this strategy perform significantly better on text processing tasks than do students using their own methods.

A second major aspect of the primary strategies is the use of knowledge schemata for organizing and retrieving information. These schemata specify the set of categories of information a well-informed learner should know about a particular topic. As an example, the following categories of information about a scientific theory were gleaned from questionnaires administered to students at a variety of educational levels:

1. Description -- A short summary of the theory.
2. Inventor/History -- A brief account of the theory's history.

3. Consequences -- A summary of how the theory has influenced man.

4. Evidence -- A summary of facts which support or refute the theory.

5. Other Theories -- A summary of theories dealing with the same phenomena.

6. X-tra Information -- An open category which includes any information not in one of the other 5 categories.

In an independent evaluation of the effects of knowledge schema training, Brooks and Dansereau (Note 3) found that this type of training significantly improved performance on a delayed essay test over a 2,500-word passage on the theory of plate tectonics.

The major component of the support strategies is concentration management. This component, which is designed to help the student set and maintain constructive moods for studying and task performance, consists of a combination of elements from systematic desensitization (Jacobsen, 1938; Wolpe, 1969), rational behavior therapy (Ellis, 1963, Maultsby, 1971), and therapies based on positive self-talk (Meichenbaum & Goodman, 1971; Meichenbaum & Turk, Note 16). The students are first given experiences and strategies designed to assist them in becoming aware of the negative and positive emotions, self-talk, and images they generate in facing a learning task. They are then instructed to evaluate the constructiveness of their internal dialogue and are given heuristics for making appropriate modifications.

In preparing for studying or testing sessions students report that they usually spend little or no conscious effort establishing constructive moods. To remedy this situation the student is trained on a technique that forms the basis of systematic desensitization: imagination of the target situation during relaxation. More specifically, the students are instructed to spend 2 to 3 minutes relaxing and then imagining their actions as they proceed through a productive study or test session. To help them maintain the resulting mood they are given experiences and techniques to assist them in determining when, how, and why they get distracted, the duration of their distraction periods, and their typical reactions to distraction. They are then trained to cope with distractions by using relaxation and positive self-talk and imagery to reestablish an appropriate learning state.

This particular combination of concentration management strategies has been shown to lead to significantly better performance on text processing tasks in comparison to students using their own methods (Collins et al., 1981). These strategies have been supplemented by training on goal-setting, scheduling, and monitoring (see Dansereau et al., 197[illegible]), to form the support strategy component of the program.

Overall evaluations of this program (e.g., Dansereau et al., 1979a and b) have shown that it facilitates the learning of scientific text and, consequently, should facilitate the transfer of acquired knowledge from one situation to another.

Educational Implications

Many teaching and testing methods implicitly encourage rote memorization by specifying exactly what must be learned, rewarding verbatim answers on tests, and putting little emphasis on the development of relationships between incoming and stored information. Rote memorization usually involves multiple readings of the material with little or no effort devoted to assimilating the information. Therefore, the material learned through this method usually is not meaningfully related to other stored information, which limits the facility with which such information can be retrieved and used at a later date. Such a strategy, although perhaps useful in our present educational environments, is very maladaptive in many job situations, where understanding is far more important than mere storage. Although the limitations of rote memorization have been emphasized, the same arguments probably apply to a large number of other strategies developed by students to cope with a teaching-oriented education.

By not stressing learning strategies, educators, in essence, discourage students from developing and exploring new strategies, and, in so doing, limit students' awareness of their cognitive capabilities. For example, the results of the administration of an extensive learning strategy inventory (Dansereau, Long, McDonald, & Actkinson, 1975a) indicate that even good college students have very little knowledge of alternative learning techniques. This lack of awareness obviously limits an individual's ability in a situation requiring new learning strategies. In addition, if the strategies that individuals have

spontaneously adopted do not match their cognitive capabilities, the emotional toll may be very large. Most of us know individuals who spend inordinate amounts of time memorizing college or high school materials and are still barely "getting by." Such an individual's personal, intellectual, and social development must certainly suffer from the pressures created by this use of a relatively inefficient learning strategy.

The answer to this situation is clear: Educators should be redirecting at least some of their efforts to the development and training of appropriate learning strategy skills. It is suggested that such training include an emphasis on both primary and support strategies. In particular, the strategies should be focused on creating integrated knowledge structures that would facilitate subsequent transfer (see the Introduction for a discussion of Gagne & White's 1978 formulations of integrated knowledge structures). The networking and knowledge schema strategies discussed earlier should provide good bases for the creation of integrated knowledge structures.

SECTION VI: EDUCATIONAL IMPLICATIONS OF TRANSFER-RELATED RESEARCH

Introduction

In this section teaching and learning principles that appear to have potential for facilitating transfer from one situation to another will be discussed. Only rarely will an attempt be made to distinguish between the effects of these principles on the normally hearing and the hearing impaired. In most cases the implementation procedures and the expected outcomes would be the same for both populations. However, to provide a focus the discussion will be related to instructional practices that are similar to those applicable at the National Institute for the Deaf in Rochester, New York.

In the main introduction to this paper the importance of examining the role of the learner/performer in the transfer situation was emphasized (see Figure 1). In particular, it was suggested that instructional practices should be designed to assist the individual in developing and using integrative memory structures (interrelated propositions, images, episodes, and skills). The remainder of the paper has examined research on principles that have potential for facilitating this process in four types of transfer situations: content to content, skills to skills, content to skills, skills to content. Content to content transfer would predominate in transfer between and within content courses; skills to skills transfer would occur between and within skills-oriented technical courses, as well as between skills courses and a job situation; content to skills

transfer would predominate between content and skills courses; and skills to content transfer would occur between supplementary learning problem solving courses and content courses. Although the instructional principles relevant to these four transfer areas vary to some extent, their commonalities far outweigh their differences. Further, in most real-world instructional systems, there is a greater blending of skills and content within courses then is portrayed by the simple classification that has been used to subdivide transfer-related research. Consequently, in this section this classification scheme will be abandoned in order to provide a different perspective on how these principles might be applied. For additional information, the reader is referred back to the summaries at the end of each of the previous four sections.

Implications of the transfer-related research for teaching methods, development of instructional materials and use of supplementary courses in learning and problem solving will be described in the following subsections.

Development of Instructional Materials

One of the major findings emerging from this review is the apparent importance of supplementary materials (e.g., advance organizers, adjunct questions) in facilitating retention and transfer. It is suggested that these materials act as bridges between the student's knowledge structures and learning/performance situations. The results of research with these types of materials are sufficient to warrant their extensive use in educational settings. Adjunct post questions and advance organ-

izers should be developed to bridge the "gaps" between units of instruction and between courses. One extension of this approach would be to pre-test students and provide different supplementary material depending on their existing knowledge. The development of these types of materials will require someone who is knowledgeable about broad sections of the curriculum as well as the knowledge bases of the participating students.

It would seem likely that procedures for evaluating students could be easily incorporated within a "bridging" system. This would require the development of tests that included transfer-oriented questions (i.e., high level adjunct questions, see Table 1). These types of questions would not only be useful in evaluating students' current states of transferable knowledge, but would also serve to positively direct the students' learning processes.

In addition to developing a supplementary "bridging" system, some of the research suggests that courses and series of courses should be sequenced from general concepts and principles to specific details and examples. This approach, which has been advocated by Norman (1973) and Thorndyke (1977), presumes an expository mode of teaching. However, under some conditions it may be more effective to encourage discovery learning, which tends to imply a specific to general sequence of instruction. This issue will be discussed further in the next subsection.

As a final point, the research suggests that there should be considerable benefits associated with concretizing and simplifying instructional materials. This implies a liberal

use of pictures and diagrams and a reduction in vocabulary level and syntax complexity. Attempts by the military (Sticht & Zapf, 1976) to accomplish these goals with their technical training materials should provide useful guidelines for more general implementations. However, it should be noted that re-writing text is not a substitute for teaching students effective strategies. Rather, both approaches should be undertaken in concert.

Teaching Methods

As stated earlier the evidence from the research on different teaching methods would suggest that an omnibus approach to instruction is ill-advised. Rather, instructional method should be tailored to fit the desired learning outcomes and the individual aptitudes, styles, and preferences of the learners. For example, discovery (trial and error) learning methods would be most useful in establishing a basis for "far" transfer with field independent learners, while expository (guided) teaching methods would be more effective in promoting "near" transfer with field dependent students. Since it has been found that hearing impaired students tend to be more field dependent than hearing students (Paras is & Long, 1979), it would seem reasonable to emphasize expository teaching methods and to attempt to increase the similarity ("nearness") between the training and transfer tasks in technical programs for the hearing impaired. Where further transfer is required, a combination of discovery and expository methods may be useful. Singer and Pease (1976) found that this type of combination approach was equal to a pure

discovery learning condition in its effects on retention and transfer performance. These authors conclude that at least a partial discovery instructional methodology should be used in a learning situation which does not allow for the total use of discovery methods (trial and error).

Regardless of the type of teaching method employed, the review of the literature by Gagne and White (1978) indicates that, wherever possible, concepts and principles should be presented redundantly in the form of propositions, images, episodes, and skills. Further, attempts should be made by the teacher to illustrate the interrelationship between these bodies of information.

Supplementary Courses in Learning and Problem Solving

It is clear that many students can benefit from skill and strategy training courses. Consequently, these types of courses should be integrated within existing curricula. The training programs reviewed in previous sections of this paper should provide a good starting place for the development of courses designed to meet the needs of specific curricula. It is suggeste that, if possible, the skills and strategy programs should be run in parallel with regular content courses. In this way strategies can be reinforced by content course instructions, and content course information can be used as the basis for practice materials within the skills and strategy programs.

General Conclusions

The review of transfer related research has indicated that the retention and transfer of information can be enhanced

by manipulating the instructional materials, employing effective teaching methods, and by instituting supplementary learning/ problem solving courses. It is suggested that a concerted effort be made to implement changes in all three of these areas in order to maximize the impact on educational outcomes.

TABLE 1
Types of Questions Used in Adjunct Questions Studies

Type	Description and Studies
Factual Questions	All studies compare higher order questions to some type of factual question. Factual Questions typically asked the reader to supply or recognize some item of information given in the passage. Factual questions are typically primarily verbatim as defined by Anderson (1972). Types of information requested have included names, numbers, dates, definitions, terms, etc.
Paraphrased Questions	Paraphrased questions are factual questions written with no substantive word overlap between text and question Anderson and Biddle (1975), Andre & Womack (1978), and Andre and Sola (1976).
General Questions	General questions are factual questions which refer to more than one text sentence. They are usually verbatim in nature Frase (1968).
Application Questions	Application questions require students to select a new example of a concept of principle employed in the text from among alternatives. Andre (Note 10), Dapra & Felker (Note 7), Moore (Note 8), Shavelson et al (1974), Watts & Anderson (1971)
Meaningful Learning Questions or Inference Questions	These questions require a reader to state a relationship between elements of the passage that is implied but not explicitly stated in the passage. Frase (1969a, b; 1970a, b; 1972), Frase and Selbiger (1970), McKenzie (1972), Rickards (1976a, b), Rickards and Hatcher (Note 2), Rickards and DiVeste (1974), Watts (1974).
Higher-Order Questions, Analysis Questions, and Evaluation Questions	Usually defined as being above the memory level of the Bloom et al (1956) Taxonomy or at some specific level of the Taxonomy and not further defined. Allen (1970), Hunkins (1969), McConkie et al (1973), Shavelson et al (1974).

Figure Captions

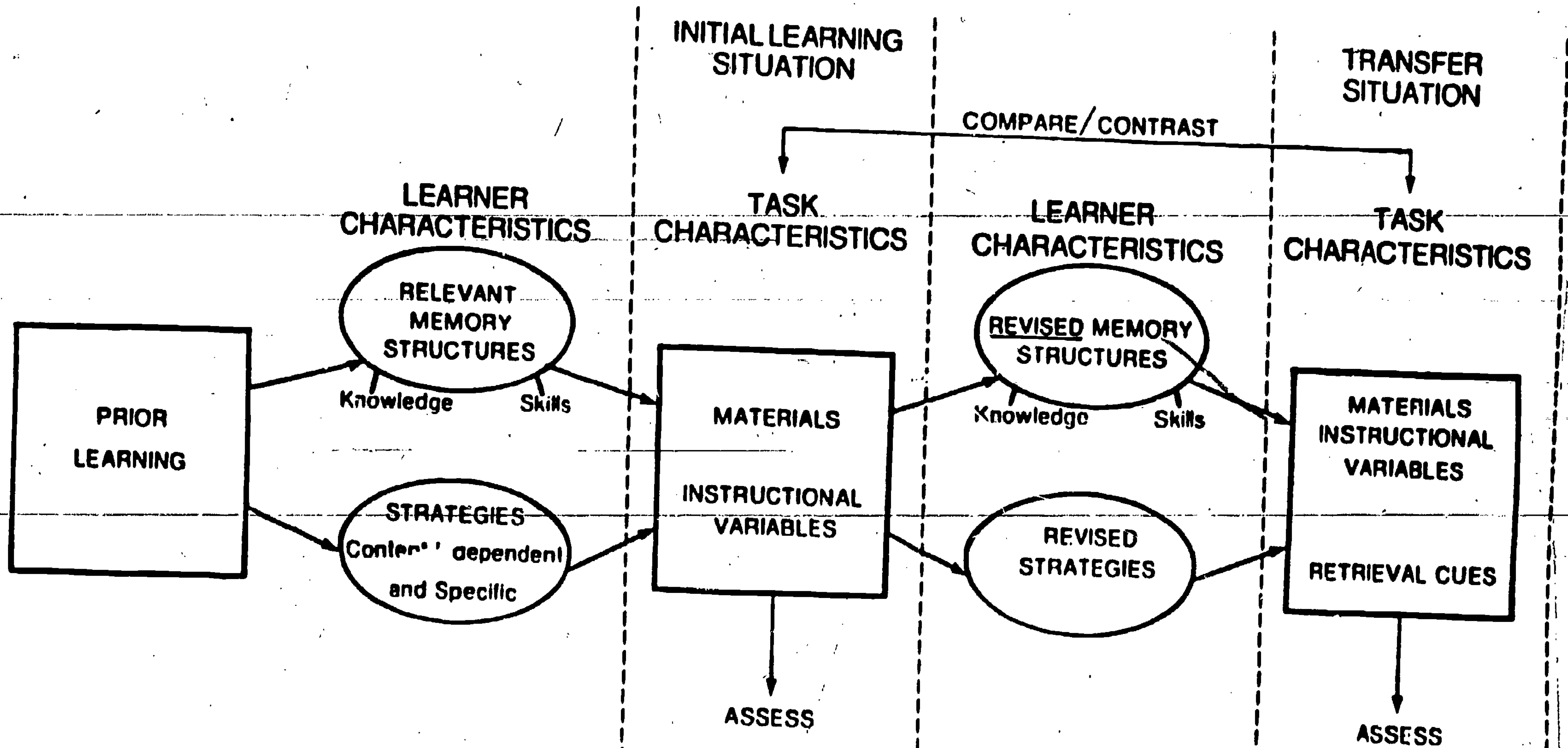
Figure 1. Transfer

Figure 2. Diagram illustrating interrelations and memory structures and performance outcomes.

Figure 3. Four types of transfer.

Figure 4. Hierarchy, chain, and cluster structures.

Figure 5. Summary map of a nursing textbook chapter.


INITIAL LEARNING SITUATION
TRANSFER SITUATION
COMPARE/CONTRAST
LEARNER CHARACTERISTICS
TASK CHARACTERISTICS
LEARNER CHARACTERISTICS
TASK CHARACTERISTICS
PRIOR LEARNING
RELEVANT MEMORY STRUCTURES
Knowledge
Skills
STRATEGIES
Conter' ' dependent
and Specific
MATERIALS
INSTRUCTIONAL VARIABLES
ASSESS
REVISED MEMORY STRUCTURES
Knowledge
Skills
REVISED STRATEGIES
MATERIALS INSTRUCTIONAL VARIABLES
RETRIEVAL CUES
ASSESS

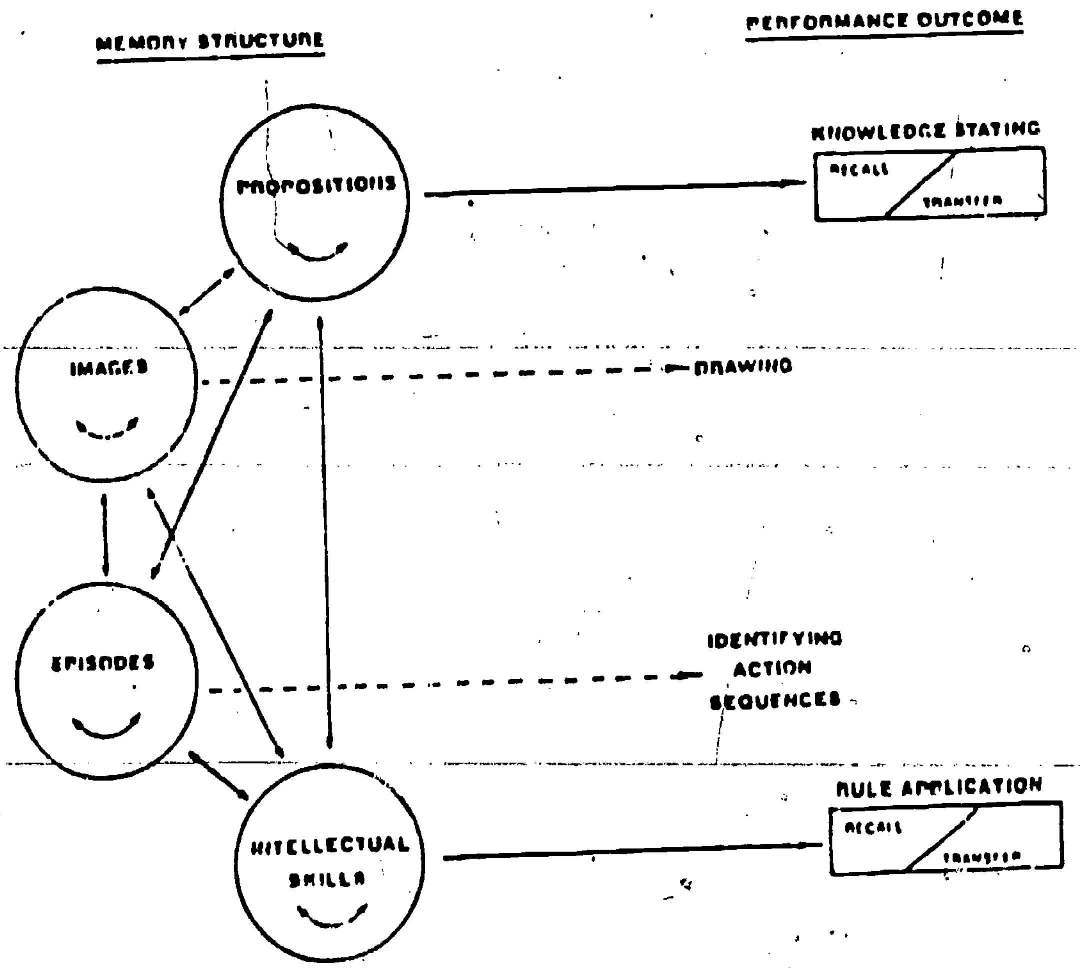


Figure #2 from Gagne, R. M. Memory structures and learning outcomes. Review of Educational Research, 1978, 48(2), 187-222. Reprinted by permission.

CONTENT TO CONTENT

(GENERAL PSYCH TO ABNORMAL PSYCH)

SKILLS TO SKILLS

(RIDING BICYCLE TO DRIVING CAR)

CONTENT TO SKILLS

(LEARNING ABOUT COMPUTERS TO LEARNING TO PROGRAM)

SKILLS TO CONTENT

(CONSTRUCTION OF ELECTRONIC CIRCUITS TO ELECTRONIC THEORY)

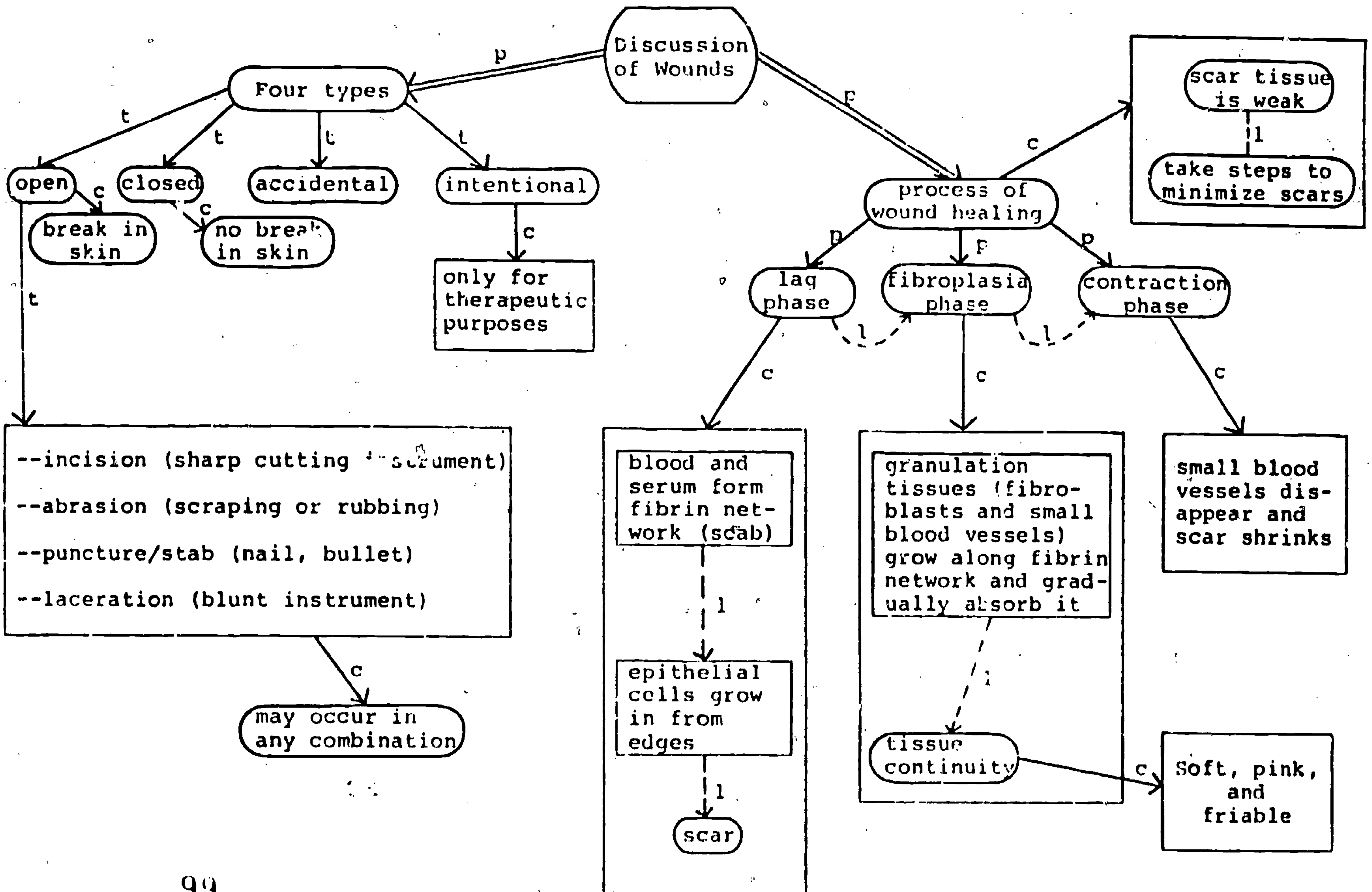
hand $\xrightarrow{p}$ finger	The content in a lower node is part of the object, process, idea or concept contained in a higher node.	Key Words is a part of is a segment of is a portion of
e (of)/ ple (of) Link school $\xrightarrow{t}$ private	The content in a lower node is a member or example of the class or category of processes, ideas, concepts, or objects contained in a higher node.	Key Words is a type of is in the category is an example of is a kind of Three procedures are

CHAIN STRUCTURES

s to Link ractice $\xrightarrow{l}$ erfection	The object, process, idea, or concept in one node leads to or results in the object, process, idea, or concept in another node.	Key Words leads to results in causes is a tool of produces

CLUSTER STRUCTURES

gy Link $\xrightarrow{a}$ factory	The object, idea, process, or concept in one node is analogous to, similar to, corresponds to, or is like the object, idea, process, or concept in another node.	Key Words is similar to is analogous to is like corresponds to
cteristic k $\xrightarrow{c}$ blue	The object, idea, process, or concept in one node is a trait, aspect, quality, feature, attribute, detail, or characteristic of the object, idea, process, or concept in another node.	Key Words has is characterized by feature is property is trait is aspect is attribute is
nce Link $\xrightarrow{e}$ x-ray	The object, idea, process, or concept in one node provides evidence, facts, data, support, proof, documentation, confirmation for the object, idea, process or concept in another node.	Key Words indicates illustrated by demonstrated by supports documents is proof of confirms



Discussion of Wounds
p
Four types
t
open
c
break in skin
t
closed
c
no break in skin
t
accidental
t
intentional
c
only for therapeutic purposes
t
--incision (sharp cutting instrument)
--abrasion (scraping or rubbing)
--puncture/stab (nail, bullet)
--laceration (blunt instrument)
c
may occur in any combination
p
process of wound healing
c
scar tissue is weak
l
take steps to minimize scars
p
lag phase
l
p
fibroplasia phase
l
p
contraction phase
c
blood and serum form fibrin network (scab)
l
epithelial cells grow in from edges
l
scar
c
granulation tissues (fibroblasts and small blood vessels) grow along fibrin network and gradually absorb it
l
tissue continuity
c
Soft, pink, and friable
c
small blood vessels disappear and scar shrinks

Reference Notes

1. Carroll, J. B. Learning from verbal discourse in educational media: A review of the literature. (ETSRB-71-61). Princeton, N. J.: Educational Testing Service, October 1971.

2. Fredrick, W. C. A comparison of verbal statement, symbolic notation, and figural representation of programmed structural grammar. Paper presented at the American Educational Research Association, Los Angeles, February 1969.

3. Brooks, L. W., & Dansereau, D. F. Knowledge schema training, field dependence, and descriptive prose processing. Manuscript submitted for publication, 1980.

4. Dapra, R. A., & Felker, D. B. Effects of comprehension and verbatim adjunct questions on problem-solving ability from prose material: Extension of the mathemagenic hypothesis. Paper presented at the Annual Convention of the American Psychological Association, New Orleans, 1974.

5. Snow, R. E., Shuell, T. J., & Marshalek, B. Individual differences in learning related processes: A prospectus. Unpublished manuscript, Stanford University, 1975.

6. Driver, M. Conceptual structure and group processes in an internotion simulation. Part one: The perception of simulated motions. Educational Testing Service Research Bulletin, RB62-15, 1962.

7. Saloman, G. Training for response uncertainty. Paper presented at the 76th Annual Convention of the American Psychological Association. San Francisco, 1968.

8. Witkin, H. A., Oltman, P. K., Cox, P. W., Ehrlichman E., Hamm, R. M., & Ringler, R. W. Field dependence-independence and psychological differentiation. Educational Testing Service Research Bulletin, RB-73-62, 1973.

9. Beller, E. K. Methods of language training and cognitive styles in lower class children. Paper presented at the meeting of the American Educational Research Association, New York, February, 1967.

10. Scott, N., & Sigel, I. E. Effects of inquiry training in physical science on creativity and cognitive styles of elementary school children. Research Report for United States Office of Education, 1965.

11. Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. Field-dependent and field-independent cognitive styles and their educational implications. (Research Bulletin 75-24) Educational Testing Service, 1975.

12. Green, A. M., Green, E. E., & Walters, E. D. Brain wave training, imagery, creativity and integrative experiences. Paper presented at the first annual symposium on Biofeedback for Counseling, Education, and Psychotherapy, V. A. Hospital Topeka, Kansas, 1973.

13. Russell, D. G. Location cues and the generation of movement. Paper presented at the National Convention of the North American Society for the Psychology of Sport and Physical Activity, Anaheim, Calif., 1974.

14. McConkie, G. W., Rayner, K., & Mayer, B. J. Manipulating reading strategies through pay-off conditions. Unpublished manuscript, Cornell University, 1971.

15. Bauman, D. J., & Glass, G. V. The effect on learning of the position of an organizer. Paper presented at the meeting of the American Educational Research Association, Los Angeles, February, 1969.

16. Meichenbaum, D. H., & Turk, D. The cognitive-behavioral management of anxiety, anger, and pain. Paper presented at the Seventh Banff International Conference on Behavior Modification, Canada, May 1975.

References

Adams, J. A. A closed-loop theory of motor learning. Journal of Motor Behavior, 1971, 3, 111-150.

Adams, H. E., & Vidulich, R. N. Dogmatism and belief congruence in paired-associate learning. Psychological Reports, 1962, 10, 41-94.

Alabiso, F. Operant control of attention behavior: A treatment for hyperactivity. Behavior Therapy, 1975, 6, 39-42.

Allen, M. S. Morphological creativity. Englewood Cliffs, N. J.: Prentice-Hall, 1962.

Allen, K. Some effects of advance organizers and levels of questions on the learning and retention of written social studies materials. Journal of Educational Psychology, 1970, 61(5), 333-339.

Anderson, J. R., & Bower, G. H. Human associative memory. Washington, D. C.: Winston, 1973.

Anderson, R. C. Control of student mediating processes during verbal learning and instruction. Review of Educational Research, 1970, 40(3), 349-369.

Anderson, R. C. & Biddle, W. B. On asking people questions about what they are reading. In G. Bower (Ed.), Psychology of learning and motivation (Vol. 9). New York: Academic Press, 1975.

Anderson, R. C., & Hidde, J. L. Imagery and sentence learning. Journal of Educational Psychology, 1971, 62, 526-530.

Anderson, R. C. Pichert, J. W., Goetz, E. T., Schallert, D. L., Stevens, K. V., & Trollip, S. R. Instantiation of general terms. Journal of Verbal Learning & Verbal Behavior, 15, 667-679, 1976.

Anderson, R. C., Reynolds, R. E., Schallert, D. L., & Goetz, E. T. Frameworks for comprehending discourse. American Educational Research Journal, 1977, 14, 367-381.

Anderson, R. C., Spiro, R. J., & Anderson, M. C. Schemata as scaffolding for the representation of information in connected discourse. (Tech. Rep. 24). Urbana, Ill.: University of Illinois at Urbana-Champaign, Center for the Study of Reading, March 1977.

Anderson, T. H. Anderson, R. C. Dalgaard, B., Paden, D., Biddle, W., Surber, J., & Alessi, S. An experimental evaluation of a computer based study management system. Educational Psychologist, 1975, 11, 184-190.

Andre, T. Does answering high-level questions while reading facilitate productive learning? Review of Educational Research, 1979, 49(2), 280-318. Copyright 1979, American Educational Research Association, Washington, D. C.

Atkin, J. M. Behavioral objectives in curriculum design: A cautionary note. The Science Teacher, 1968, 35, 27-30.

Ausubel, D. P. The psychology of meaningful verbal learning. New York: Grune & Stratton, 1963.

Ausubel, D. P. Educational psychology: A cognitive view. New York: Holt, Rinehart, & Winston, 1968.

Ausubel, D. P. In defense of advance organizers: A reply to the critics. Review of Educational Research, Spring, 1978, 48(2), 251-257.

Ausubel, D. P., & Fitzgerald, D. The role of discriminability in meaningful verbal learning and retention. Journal of Educational Psychology, 1961, 52, 266-274.

Ausubel, D. P., & Youssef, M. The effect of consolidation on sequentially related, sequentially independent meaningful learning. Journal of General Psychology, 1966, 74(2), [illegible]5-36

Barnes, B. R., & Clawson, E. W. Do advance organizers facilitate learning? Recommendations for further research based on an analysis of 32 studies. Review of Educational Research 1975, 45, 637-659.

Barrett, G. V., & Thornton, D. L. Cognitive style differences between engineers and college students. Perceptual and Motor Skills, 1967, 25, 789-793.

Barrett, G. V., & Thornton, C. L. Relationship between perceptual style and driver reaction to an emergency situation. Journal of Applied Psychology, 1968, 52, 169-176.

Bartlett, F. Thinking: An experimental and social study. London: Allen & Unwin, 1958.

Beighley, K. C. Experimental study of the effect of four speech variables on listener comprehension. Speech Monographs, 1952, 19, 249-258.

Belcastro, F.P. Relative effectiveness of the inductive and deductive methods of programming algebra. Journal of Experimental Education, Spring, 1966, 34(3), 77-82.

Benfari, R., & Vitale, P. Relationship between vertical orientation in the rod and frame test and in a compensatory tracking task. Perceptual and Motor Skills, 1965, 20, 1073-1080.

Berg, K. S. & Stone, G. L. Modeling and instructional effects as a function of conceptual level. Canadian Journal of Behavioral Science/Revue canadienne des Sciences du comportement, 10(2), 1978, 152-161.

Berry, G., Prather, D., & Jones, G. Effect of prompting and feedback on the learning of a perceptual skill. Proceedings of the 79th Annual Convention of the American Psychological Association, 1971, 6, 589-590.

Bieri, J. Category width as a measure of discrimination. Journal of Personality, 1969, 37, 513-521.

Biggs, J. B. Faculty patterns in study behavior. Australian Journal of Psychology, 1970, 22(2), 161-173. (a)

Biggs, J. B. Personality correlates of certain dimensions of study behavior. Australian Journal of Psychology, 1970, 22(3), 287-297. (b)

Bledsoe, J. C. Purser, J. D., & Frantz, N. R. Effects of manipulative activities on arithmetic achievement and retention. Psychological Reports, 1974, 35, 247-252.

Bodden, J. L., Osterhouse, R., & Gelso, C. The value of a study skills inventory for feedback and criterion purposes in an educational skills course. Journal of Educational Research, 1972, 65(7), 309-311.

Bormuth, J. R. Readability: A new approach. [illegible]ding Research Quarterly, 1966, 1(3), 79-132.

Bourne, L. E., Jr. Factors affecting strategies used in problems of concept formation. American Journal of Psychology, 1963, 76, 229-238.

Bower, G. H. How to ...uh...remember! Psychology Today, 1973, 7, 62-67.

Bower, G. H. Cognitive psychology: An introduction. In W. K. Estes (Ed.), Handbook of learning and cognitive processes (Vol. 1). Hillsdale, N. J.: Erlbaum Associates, 1975.

Bower, G. H., & Reitman, J. S. Mnemonic elaboration in multilist learning. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 478-485.

Bransford, J. D., & Johnson, M. K. Considerations of some problems of comprehension. In W. G. Chase (Ed.), Visual information processing. New York: Academic Press, 1973, 383-438.

Briggs, R. D., Tosi, D. J., & Morley, R. M. Study habit modification and its effect on academic performances: A behavioral approach. Journal of Educational Research, 1971, 64(8), 347-350.

Brown, W. F., & Holtzman, W. H. Survey of study habits and attitudes. Form C. New York: The Psychological Corporation, 1966.

Brown, A. L., Smiley, S. S., Day, J. D., Townsend, M. A. R., & Lawton, S. C. Intrusion of a thematic idea in children's comprehension and retention of stories. Child Development, 1977, 47(2), 1454-1466.

Brown, W. F., Webe, N. D., Zunker, V. G., & Haslam, W. L. Effectiveness of student to student counseling on the academic adjustment of potential college dropouts. Journal of Educational Psychology, 1971, 62, 285-289.

Bruininks, R. H. Auditory and visual perceptual skills related to the reading performance of disadvantaged boys. Perceptual and Motor Skills, 1969, 29, 179-186.

Bruner, J. S. Toward a theory of instruction. Cambridge: Harvard University Press, 1966.

Bruner, J. S., Goodnow, J. J., & Austin, G. A. A study of thinking. New York: Wiley, 1956.

Butterfield, E. C., Belmont, J. M., & Peltzman, D. J. Effects of recall requirement on acquisition strategy. Journal of Experimental Psychology, 1971, 90(2), 347-348.

Caldwell, V. R., Schroder, D. B., Michael, W. B., & Meyers, C. E. Structure of intellect measures and other tests as predictors of success in tenth-grade geometry. Educational and Psychological Measurement, 1970, 30, 437-441.

Cermak, L. S. Rehearsal strategy as a function of recall expectation. Quarterly Journal of Experimental Psychology, 1972, 24, 378-385.

Claunch, N. C. Cognitive and motivation characteristics associated with concrete and abstract level of conceptual complexity. Joint ONR and NIMH Report, Princeton University, 1964.

Cody, M. An investigation of the relative effectivensss of four modes of presenting meaningful material to twelfth grade students. Doctoral dissertation, Fordham University, 1962, Ann Arbor, Mich.: University Microfilm, 1962, No. 62-3759.

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, A. M., Weinfeld, F. D., & York, R. L. Equality of educational opportunity, Washington, D. C., United States Government Printing Office, 1966.

Collins, K. W., Dansereau, D. F., Holley, C. D., & McDonald, B. A. Control of concentration during academic tasks. Journal of Educational Psychology, 1981, 73(1), 122-128.

Covington, M. V., Crutchfield, R. S., Davis, L., & Olton, R. M. The productive thinking program: A course in learning to think. Columbus, Ohio: Merrill, 1974.

Crutchfield, R. S. Creative thinking in children: Its teaching and testing. In O. G. Brim, R. S. Crutchfield, & W. H. Holtzman (Eds.), Intelligence: Perspectives, 1965. New York: Harcourt Brace, Jovanovich, 1966.

Crutchfield, R. S., Woodworth, D. C., & Albrecht, R. E. Perceptual performance and the effective person. WADC-TN-58060, ASTIA Doc. No. AD 151-039, 1958.

Danner, F. W., & Taylor, A. M. Integrated pictures and relational imagery training in children's learning. Journal of Experimental Child Psychology, 1973, 16, 47-54.

Dansereau, D. F. The development of a learning strategy curriculum. In H. F. O'Neil, Jr., (Ed.), Learning strategies. New York: Academic Press, 1978.

Dansereau, D. F., Actkinson, T. A., Long, G. L., & McDonald, B. A. Learning strategies: A review and synthesis of the current literature (AFHRL-TR-74-70, Contract F41609-74-C-0013). Lowry Air Force Base, Colorado: Air Force Human Resources Laboratory, 1974. (AD-07722)

Dansereau, D. F., Collins, K. W., McDonald, B. A., Garland, J. C., Holley, C. D., Evans, S. H., & Diekhoff, G. M. Learning strategy training materials: A selected subset. AFHRL-TR-78-64, Lowry Air Force Base, Colorado: Air Force Human Resources Laboratory, Technical Training Division, September, 1978. (AD-062739)

Dansereau, D. F., Collins, K. W., McDonald, B. A., Holley, C. D., Garland, J., Diekhoff, G. M., & Evans, S. H. Development and evaluation of an effective learning strategy program. Journal of Educational Psychology, 1979, 71(1), 64-73. (a)

Dansereau, D. F., Evans, S. H., Wright, A. D., Long, G. L., & Actkinson, T. A. Factors related to developing instructional information sequences: Phase I. (AFHRL-TR-63-51 (I)) Lowry Air Force Base, Colorado: Air Force Human Resources Laboratory, Technical Training Division, March, 1974. (NTIS NO. AD 777-832)

Dansereau, D. F., Long, G. L., Evans, S. H., & Actkinson, T. R. Objective ordering of instructional material using multidimensional scaling. Journal of Structural Learning, 1980(6), 299-314.

Dansereau, D. F., Long, G. L., McDonald, B. A., & Actkinson, T. R. Learning strategy inventory development and assessment (AFHRL-TR-75-40, Contract F41609-74-C-0013). Lowry Air Force Base, Colorado: Air Force Human Resources Laboratory, 1975. (AD-A01472) (a)

Dansereau, D. F., Long, G. L., McDonald, B. A., Actkinson, T. R., Ellis, A. M., Co-lins, K. W., Williams, S., & Evans, S. H. Effective learning strategy training program: Development and assessment (AFHRL-TR-75-41, Contract F41609-74-0013). Lowry Air Force Base, Colorado: Air Force Human Resources Laboratory, 1975. (AD-A014722) (b)

Dansereau, D. F., Long, G. L., McDonald, B. A., Actkinson, T. R., Collins, K. W., Evans, S. H. Ellis, A. M., & Williams, S. Learning strategy training program: Paraphrasing strategy for effective learning. AFHRL-TR-75-46, Final Report, Contract F41609-74-C-0013, Air Force Systems Command, Brooks Air Force Base, Texas, June, 1975. (AD-A014-723) (c)

Dansereau, D. F., et al. Learning strategy training program: Visual imagery for effective learning, (AFHRL-TR-75-47, Final Report, Contract F41609-74-C-0013, Air Force Systems Command Brooks Air Force Base, Texas, June 1975. (AD-A014-724) (d)

Dansereau, D. F., et al. Learning strategy training program: Questions and answers for effective learning. AFHRL-TR-75-48, Final Report, Contract F41609-74-C-0013, Air Force Systems Command, Brooks Air Force Base, Texas, June 1975. (AD-A014-725) (e)

Dansereau, D. F., McDonald, B. A., Collins, K. W., Garland, J. C., Holley, C. D., Diekhoff, G., & Evans, S. H. Development and evaluation of a learning strategy system. In H. F. O'Neil, Jr., & C. D. Spielberger (Eds.), Cognitive and affective learning strategies. New York: Academic Press, 1979. (b)

Davis, G. A., Houtman, S. E., Warren, T. R., & Roweton, W. E. A program for training creative thinking: I. Preliminary field test. Wisconsin Research and Development Center for Cognitive Learning and the Department of Educational Psychology, University of Wisconsin, 1969.

Davis, W. L., & Phares, E. J. Internal-external control as determinants of information-seeking in a social influence situation. Journal of Personality, 1967, 35, 547-561.

Dawson, D. T., &Ruddell, A. K. An experimental approach to the division idea. The Arithmetic Teacher, 1955, 2, 6-9.

DeCaro, J. J. A hierarchy of skills as an organizational aid in a programmed instruction sequence with deaf persons. Doctoral dissertation, Syracuse University, 1977. Dissertation Abstracts International 38108A, p. 4674.

DelGiorno, W., Jenkins, J. R., & Bausell, R. B. Effects of recitation in the acquisition of prose. Journal of Educational Research, 1974, 67, 293-294.

Dentler, R. A., & Mackler, B. Originality: Some social and personal determinants. Behavioral Science, 1964, 9, 1-7.

DeRussy, E. A., & Futch, E. Field dependence-independence as related to college curricula. Perceptual and Motor Skills, 1971, 33, 1235-1237.

DiVesta, F. J., Schultz, C. B., & Dangel, I. R. Passage organization and imposed learning strategies in comprehension and recall of connected discourse. Memory and Cognition, 1973, 1, 471-476.

Doebler, L. K., & Eicke, F. J. Effects of teacher awareness of the educational implication of field-dependent/field-independent cognitive style on selected classroom variables. Journal of Educational Psychology, 1979, 71(2), 226-232.

Dubin, R., & Taveggia, T. C. The teaching-learning paradox. Eugene: University of Oregon Press, 1968.

Duncan, C. P. Descriptions of learning to learn in human subjects. American Journal of Psychology, 1960, 73, 108-114.

Dunham, J. L., Builford, J. P., & Hoepfner, R. Multivariate approaches to discovering the intellectual components of concept learning. Psychological Review, 1968, 75, 206-221.

Dwyer, F. M., Jr. Adapting visual illustrations for effective learning. Harvard Educationa. F [illegible] 1967, 37, 250-263.

Eagle, M., Goldberger, L., & Brei[illegible] M. Field dependence and memory for social vs. neutral [illegible]t vs. irrelevant incidental stimuli. Perceptua[illegible] Skills, 1969, 29, 903-910.

Egan, D. E., & Greeno, J. G. Acquiring cognitive structure by discovery and rule learning. Journal of Educational Psychology, 1973, 64, 85-97.

Eisner, E. W. Educational objectives. Help or hindrance. School Review, 1967, 75, 251-282.

Ellis, A. Reason and emotion in psychotherapy. New York: Lyle Stuart, 1963.

Ernst, G. W., & Hewell, A. GPS: A case study in generality and problem solving. New York: Academic Press, 1969.

Estes, W. K. The state of the field: General problems and issues of theory and metatheory. In W. K. Estes (Ed.), Handbook of learning and cognitive processes (Vol. 1). Hillsdale, New Jersey: Erlbaum Associates, 1975.

Fennema, E. H. The relative effectiveness of a symbolic and a concrete model in learning a selected mathematical principle. Journal for Research in Mathematics Education, 1972, 3, 233-238.

Ferrell, J. F. The differential performance of lower class, preschool, Negro children as a function of the sex of E, sex of S, reinforcement condition, and level of field dependence. Doctoral dissertation, University of Southern Mississippi, 1971. Dissertation Abstracts International, 1971, 32, 3028B-3929B. (University Microfilms 71-28, 831.)

Fitts, P. M., & Posner, M. I. Human performance. Belmont, California: Brooks/Cole, 1967.

Frase, L. T. Effect of question location, pacing, and mode upon retention of prose material. Journal of Educational Psychology, 1968, 59, 224-248.

Frase, L. T. Paragraph organization of written materials: The influence of conceptual clustering upon level and organization of recall. Journal of Educational Psychology, 1969, 60, 394-401.

Frase, L. T. Integration of written text. Journal of Educational Psychology. 1973, 65, 252-261.

Gagne, R. M. Curriculum research and promotion of learning. Perspectives of curriculum education. AERA Monograph Series on Curriculum Education: Monograph No. 1. Chicago: Rand McNally, 1967.

Gagne, R. M. Domains of learning. Interchange, 1972, 3, 1-8.

Gagne, R. M. The learning basis of teaching methods. In N. L. Gage (Ed.), The psychology of teaching methods. Seventy-fifth Yearbook, National Society for the Study of Education, Part I. Chicago: Chicago University Press, 1976.

Gagne, R. M., & White, R. T. Memory structures and learning outcomes. Review of Educational Research, 1978, 48(2), 187-222. Copyright, 1978, American Educational Research Association, Washington, D.C.

Gardner, R. W. Cognitive styles in categorizing behavior. Journal of Personality, 1953, 22, 214-233.

Gay, L. R. Temporal position of reviews and its effect on the retention of mathematical rules. Tallahasee: Florida State University Computer-Assisted Instruction Center (Contract N00014-68-A-1494), Personnel and Training Research Program, Office of Naval Research, April 1971. (AD 279-055)

Gerlach, V. S., Schultz, R. E., Baker, R. L., . Mazer, G. E. Effects of variations in directions on originality test response. Journal of Educational Psychology, 1964, 55, 79-83.

Ghiselin, B. The creative process. Berkeley, California: University of California Press, 1952.

Glaser, R. Objectives and evaluation: An individualized system. Science Education News. American Association for the Advancement of Science, 1967, 1-3.

Goldman, R., & Warren, R. Discriminant analysis of study strategies connected with college grade success in different major fields. Journal of Educational Measurement, 1973, 10, 39-47.

Grieve, T. D., & Davis, J. K. The relationship of cognitive style and method of instruction to performance in ninth grade geography. Journal of Educational Research, 1971, 65, 137-141.

Groninger, L. D. Mnemonic imagery and forgetting. Psychonomic Science, 1971, 23(2), 161-163.

Guilford, J. P., & Hoepfner, R. The analysis of intelligence. New York: McGraw-Hill, 1971.

Guilford, J. P., Hoepfner, R., & Peterson, H. Prediction of achievement in ninth-grade mathematics from measures of aptitude factors. Educational and Psychological Measurement, 1965, 25, 659-682.

Guthrie, J. T. Instruction versus a discovery method. Journal of Educational Psychology, 1967, 58, 45-49.

Hartley, J., & Davies, L. K. Preinstructional strategies: The role of pretests, behavioral objectives, overviews, and advance organizers. Review of Educational Research, 1976, 46, 239-265.

Hartnett, R. T. Learning style preferences among college students. College Entrance Examination Board Research and Development Reports, RB-73-14, 1973.

Haslam, W. L., & Brown, W. G. Effectiveness of study skills instruction for high school sophomores. Journal of Educational Psychology, 1968, 59, 223-226.

Hersch, P. D., Scheibe, K. G. Reliability and validity of internal-external control as a personality dimension. Journal of Consulting Psychology, 1967, 31, 609-613.

Hester, F. M., & Tagatz, G. B. The effects of cognitive style and instructional strategy on concept attainment. Journal of General Psychology, 1971, 85, 229-237.

Hills, J. R. Factor analyzed abilities and success in college mathematics. Educational and Psychological Measurement, 1957, 17, 615-622.

Holding, D. F. Principles of training. New York: Pergamon, 19

Holley, C. D., Dansereau, D. F., McDonald, B. A., Garland, J. C. & Collins, K. W. Evaluation of a hierarchical mapping technique as an aid to prose processing. Contemporary Educationa Psychology, 1979, 4, 227-237.

Houston, J. P. Verbal transfer and interlist similarities. Psychological Review, 1964, 71, 412-414.

Houston, J. P. Transfer as a function of the similarity between first-list stimuli and second-list responses. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 322-323

Hunt, E. We know who knows, but why? In R. C. Anderson, R. J. Spiro, and W. E. Montague (Eds.), Schooling and the acquisition of knowledge, Hillsdale, New Jersey: Erlbaum & Associates, 1977.

Hyman, R. On prior information and creativity. Psychological Reports, 1961, 9, 151-161.

Jacobsen, E. Progressive relaxation. Chicago: University of Chicago Press, 1938.

Jacoby, L. L. Test appropriate strategies in retention of categorized lists. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 675-685.

James, N. E. Personal preference for method as a factor in learning. Journal of Educational Psychology, 1962, 53, 43-47

Johnson, D. M., Parrott, G. L., & Stratton, R. P. Production and judgment of solutions to five problems. Journal of Educational Psychology, 1968, 59, (Monograph Supplement No. 6

Julian, J. W., & Katz, S. B. Internal control and the value of reinforcement. Journal of Personality and Social Psycholo 1968, 8, 89-94.

Johnson, R. E. Abstract processes in the remembering of prose. Journal of Educational Psychology, 1974, 66, 772-779.

Kagan, J., Moss, H. A., & Sigel, I. G. The psychological significance of styles of conceptualization. In J. F. Wright and J. Kagans (Eds.), Basic Cognitive Processes in Children. Monograph of the Society for Research in Child Development, 1963, 28, 73-112.

Kagan, J., Rosman, B., Day, D., Albert, J., & Phillips, W. Information processing in the Child: Significance of analytic and reflective attitudes. Psychological Monographs, 1964, 78, (1, Whole No. 578).

Katona, G. Organizing and memorizing. New York: Columbia University Press, 1940.

Kennedy, R. S. The relationship of field independence, extraversion, and neuroticism to success in naval aviation training. Appendix A. Unpublished doctoral dissertation, University of Rochester, 1972.

Keogh, B. K., & Donlon, G. McG. Field dependence, impulsivity, and learning disabilities. Journal of Learning Disabilities, 1972, 5, 16-21.

King, D. J. Retention of connected meaningful material as a function of mode of presentation and recall. Journal of Experimental Psychology, 1968, 77, 676-683.

King, D. J., & Madill, J. Complex methods of presentation, internal consistency of learning material, and accuracy of written recall. Psychological Reports, 1968, 22, 777-782.

Kintsch, W., Kosminsky, E., Streby, W. J., McKoon, G., & Keenan, J. M. Comprehension and recall of text as a function of content variables. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 196-214.

Klare, G. R. The measurement of readability. Ames, Iowa: Iowa State University Press, 1963.

Klausmeier, H. J., & Meinke, D. L. Concept attainment as a function of instructions concerning the stimulus material, a strategy, and a principle for securing information. Journal of Educational Psychology, 1968, 59, 215-222

Kleck, R. E., & Wheaton, J. Dogmatism and responses to opinion-consistent and opinion-inconsistent information. Journal of Personality and Social Psychology, 1967, 5(2), 249-252.

Koestler, A. The act of creation. New York: Macmillan, 1964.

Konstadt, N., & Forman, E. Field dependence and external directedness. Journal of Personality and Social Psychology, 1965, 1, 490-493.

Lave, J. Tailor-made experiments and evaluating the intellectual consequences of apprenticeship training. In Hall & Cole, Child Development, 1977, 1, 1-3.

Lawton, J. P., & Wanska, J. K. Advance organizers as a teaching strategy: A reply to Barnes & Clawson. Review of Educational Research, 1977, 47, 233-244.

Lee, L. C., Kagan, J., & Rabson, A. The influence of a preference for analytic categorization upon concept acquisition. Child Development, 1963, 34, 433-442.

Levine, J. R., & Divine-Hawkins, P. Visual imagery as a prose learning process. Journal of Reading Behavior, 1974, 6, 23-30.

Long, G. L. The development and assessment of a cognitive process based learning strategy training program. Unpublished doctoral dissertation. Texas Christian University, 1976.

Lordahl, D. S. Concept identification using simultaneous auditory and visual signals. Journal of Experimental Psychology, 1961, 62, 283-290.

Lowry, D. H. The effects of mnemonic learning strategies on transfer, interference, and 48-hour retention. Journal of Experimental Psychology, 1974, 103(1), 16-20.

Macrae, A. W., & Holding, D. H. Rate and force of guidance in perceptual-motor tasks with reversed or random spatial correspondence. Ergonomics, 1966, 9, 289-296.

Mager, R. F. Deriving objectives for the high school curriculum. National Society Programmed Instructional Journal, 1968, 7, 7-14.

Maier, N. R. F. Reasoning in humans. I. On direction. Journal of Comparative Psychology, 1930, 10, 115-143.

Mansfield, R. S., Busse, T. V., & Krepelka, E. J. The effectiveness of creativity training. Review of Educational Research, 1978, 48(4), 517-536.

Marteniuk, R. G. Information processing in motor skills. Holt, Rinehart, & Winston, New York, 1976.

Maultsby, M. Handbook of rational self-coaching. Madison, Wisconsin: Association for Rational Thinking, 1971.

Mayer, R. E. Acquisition processes and resilience under varying testing conditions of structurally different problem solving procedures. Journal of Educational Psychology, 1974, 66, 644-656.

Mayer, R. E. Forward transfer of different reading strategies evoked by testlike events in mathematics text. Journal of Educational Psychology, 1975, 67(2), 165-169.

Mayer, R. E. Information processing variables in learning to solve problems. Review of Educational Research, 1975, 45, 525-541.

Mayer, R. E. Some conditions of meaningful learning for computer programming: Advance organizers and subject control of frame order. Journal of Educational Psychology, 1976, 68(2). 143-150.

Mayer, R. E. Advance organizers that compensate for the organization of text. Journal of Educational Psychology, December, 1978, 70(6), 880-886.

Mayer, R. E. Qualitatively different encoding strategies for linear reasoning premises: Evidence for single association and distance theories. Journal of Experimental Psychology: Human Learning and Memory, January, 1979, 5(1), 1-10.

Mayer, R. E., & Greeno, J. P. Structural differences between learning outcomes produced by different instructional methods. Journal of Educational Psychology, 1972, 63, 165-173.

Mayer, R. E., Stiehl, C. C., & Greeno, J. P. Acquisition of understanding and skill in relation to subjects' preparation and meaningfulness of instruction. Journal of Educational Psychology, 1975, 67, 331-350.

McConkie, G. W., & Meyer, B. J. Investigation of reading strategies: II. A replication of pay-off condition effects. Journal of Reading Behavior, 1974, 6, 151-158.

McConkie, G. W., & Rayner, K. Investigation of reading strategies: I. Manipulating strategies through pay-off conditions. Journal of Reading Behavior, 1974, 6, 9-18.

McConkie, G. W., Rayner, K., & Wilson, J. S. Experimental manipulation of reading strategies. Journal of Educational Psychology, 1973, 65(1), 1-8.

McLeod, D. B., & Adams, V. M. The interaction of field independence with discovery learning in mathematics. Journal of Experimental Education, Fall, 1979, 48, 32-35.

Meadow A., Parnes, S. J., & Reese, H. Influence of brainstorming instructions and problem sequence on a creative problem solving test. Journal of Applied Psychology, 1959, 43, 413-416.

Meichenbaum, D. H., & Goodman, J. Training impulsive children to talk to themselves: A means of self-control. Journal of Abnormal Psychology, 1971, 77, 115-126.

Melton, R. F. Resolution of conflicting claims concerning the effect of behavioral objectives on student learning. Review of Educational Research, Spring 1978, 48(2), 291-302.

Messick, S., & Damarin, F. Cognitive style and memory for faces. Journal of Abnormal and Social Psychology, 1964, 69, 313-317.

Meyer, B. J. F. The organization of prose and its effects on memory. Amsterdam: North-Holland Publishing Co., 1975.

Minsky, M. A framework for representing knowledge. In P. H. Winston (Ed.), The psychology of computer vision. New York: McGraw-Hill, 1975.

Miyake, N., & Norman, D. A. To ask a question, one must know enough to know what is not known. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 357-364.

Montague, W. E., & Carter, J. F. Vividness of imagery in recalling connected discourse. Journal of Educational Psychology, 1973, 64, 72-75.

Mowbray, G. H. Simultaneous vision and audition: The comprehension of prose passages with varying levels of difficulty. Journal of Experimental Psychology, 1953, 46, 365-372.

Munro, A., & Rigney, J. W. A schema theory account of some cognitive processes in complex learning. (Tech. Rep. 81) Los Angeles: University of Southern California, Department of Psychology, July 1977.

Norman, D. A. Memory, knowledge, and the answering of questions. In R. L. Solso (Ed.), Contemporary issues in cognitive psychology. The Loyola symposium. Washington, D. C.: V. H. Winston & Sons, 1973, 135-166.

Nelson, D. L., & Archer, C. S. The first letter mnemonic. Journal of Educational Psychology, 1972, 63(5), 482-486.

Newell, A., Simon, H. A., & Shaw, J. D. Elements of a theory of human problem solving. Psychological Review, 1958, 65, 151-166.

Newell, A., Simon, N. A., & Shaw, J. C. Report on a general problem solving problem. Proceedings of International Conference on Information Processing. Paris: UNESCO, 1960, 256-264.

Olton, R. M., & Crutchfield, R. S. Developing the skills of productive thinking. In P. Mussen, J., Langer, & M. Covington (Eds.), Trends and issues in developmental psychology. New York: Holt, Rinehart, & Winsson, 1969.

Osborn, A. F. Applied imagination. New York: Scribners, 1953.

Osgood, C. E. The similarity paradox in human learning: A resolution. Psychological Review, 1949, 56, 132-143.

Owens, J., Dafoe, J., & Bower, G. Taking a point of view: Character identification and attributional processes in story comprehension and memory. Memory and Cognition, 1979, in press.

Paivo, A. Imagery and verbal processes. New York: Holt, Rinehart, & Winston, 1971.

Parasnis, I., & Long, G. L. Relationships among spatial skills, communication skills, and field independence in deaf students. Perceptual and Motor Skills, 1979, 49, 879-887.

Passy, R. A. The effect of cuisenaire materials on reasoning and computation. The Arithmetic Teacher, 1963, 10, 439-440.

Patterson, C. J., & Mischel, W. Plans to resist distraction. Developmental Psychology, 1975, 11(3), 369-378.

Pettigrew, T. F. The measurement and correlates of category width as a personality variable. Journal of Personality, 1958, 26, 532-544.

Phares, E. J. Differential utilization of information as a function of internal-external control. Journal of Personality, 1968, 36, 649-662.

Polya, G. How to solve it. Garden City, New York: Doubleday Anchor, 1957.

Postman, L. Transfer, interference and forgetting. In J. W. Kling & L. A. Riggs (Eds.), Woodworth & Schlosberg's Experimental Psychology. Holt, Rinehart, & Winston, Inc., 1971.

Pylyshyn, Z. W. What the mind's eye tells the mind's brain: A critique of mental imagery. Psychological Bulletin, 1973, 80, 1-24.

Rasco, R. W., Tennyson, R. P., & Boutwell, R. C. Imagery instructions and drawings in learning prose. Journal of Educational Research, 1975, 67(2), 188-192.

Raths, J. Teaching without specific objectives. Educational Leadership, 1971, 28, 714-720.

Renzi, N. B. A study of some effects of field ndependence-independence and feedback on performance achievement. Doctoral dissertation, Hofstra University, 1974. Dissertation Abstracts International, 1974, 35. 2059A. (University Microfilms No. 74-21, 861).

Rickards, J. P. Adjunct postquestions in text: A critical review of methods and processes. Review of Educational Research, 1979, 49(2), 181-196.

Rickards, J. P., & Denner, P. R. Inserted questions as aids to reading text. Instructional Science, 1978, 7, 313-346.

Rickards, J. P., & DiVesta, F. J. Type and frequency of questions in processing textual material. Journal of Educational Psychology, 1974, 68, 354-362.

Rickards, V. P., & Hatcher, C. W. Interspersed meaningful learning questions as semantic cues for poor comprehenders. Reading Research Quarterly, 1978, 13, 538-553.

Ritter, K., Kaprove, B. H., Fitch, J. P., & Flavell, J. H. The development of retrieval strategies in young children. Cognitive Psychology, 1973, 5, 310-321.

Robinson, F. P. Effective study. New York: Harper, 1946.

Rokeach, M. The open and closed mind. New York: Basic Books, 1960.

Rosenthal, T. L., Moore, W. B., Dorfman, H., & Nelson, B. Vicarious acquisition of a simple concept with experimenter as model. Behavior Research and Therapy, 1971, 9, 219-227.

Rothkopf, E. Z. Some theoretical and experimental approaches to problems in instruction. In J. D. Krumbolz (Ed.), Learning and the Educational Process, 193-221. Chicago: McNally, 1965.

Rothkopf, E. Z. Learning from written instructive materials: An exploration of the control of inspection behavior by test-like events. American Educational Research Journal, 1966, 3(4), 241-249.

Rothkopf, E. Z., & Bisbicos, E. E. Selective facilitative effects of interspersed questions in learning from written materials. Journal of Educational Psychology, 1967, 58, 56-6

Rotter, J. B. Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 1966, 89(1), (00, Whole No. 609).

Royer, J. M. Theories of the transfer of learning. Educational Psychologist, 1979, 14, 53-69.

Royer, J. M., & Cable, G. W. Illustrations, analogies, and facilitative transfer in prose learning. Journal of Educational Psychology, 1976, 68, 205-209.

Rumelhart, D. E. Notes on a schema for stories. In D. G. Bobrow & A.M. Collins (Eds.), Representation and understanding: Studies in cognitive science. New York: Academic Press, 1975.

Rumelhart, D. E., Lindsay, P. H., & Norman, D. A. A process model for long-term memory. In E. Tulving & W. Donaldson (Eds.), Organization of memory. New York: Academic Press, 1972.

Rumelhart, D. E., & Ortony, A. The representation of knowledge in memory. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, New Jersey: Erlbaum, 1977.

Sanders, N. M., & Tzeng, O. The relationship between rote and conceptual learning. In F. J. DiVesta, N. M. Sanders, C. B. Schultz, & P. B. Weener, Instructional strategies: Multivariable studies of psychological processes related to instruction. ARPA Semi-Annual Rep., 1971.

Santa, J. C., Ruskin, A. B., & Yio, J. H. Mnemonic systems in free recall. Psychological Reports, 1973, 32, 1163-1170.

Scandura, J., & Wells, J. Advance organizers in learning abstract mathematics. American Educational Research Journal, 1967, 4, 295-301.

Schallert, D. L. Improving memory for prose: The relationship between depth of processing and context. Journal of Verbal Learning and Verbal Behavior, 1976, 15, 621-632.

Schank, R., & Abelson, R. P. Scripts, plans, and knowledge. Proceedings of the Fourth International Joint Conference on Artificial Intelligence. Tbilisi, Georgia: U.S.S.R., 1975.

Schmeidler, G. K. Visual imagery correlated to a measure of creativity. Journal of Consulting Psychology, 1965, 29(1), 78-80.

Schroder, H., Driver, M., & Streufert, S. Human information processing. Holt, Rinehart, & Winston: New York, 1967.

Schultz, R. W., & Kasschau, R. A. Serial learning as a function of meaningfulness and mode of presentation with audio and visual stimuli and equivalent duration. Journal of Experimental Psychology, 1966, 71(3), 350-354.

Seeman, M., & Evans, J. W. Alienation and learning in a hospital setting. American Sociological Review, 1962, 27, 772-783.

Shavelson, R. J., Berliner, D. C., Ravitch, M. M., & Loeding, D. Effects of position and type of question on learning from prose material: Interaction of treatments with individual differences. Journal of Educational Psychology, 1974, 66, 40-48.

Sieber, J. E., & Lanzetta, J. T. Some determinants of individual differences in predecision information processing behavior. Journal of Personality, 1966, 4, 561-571.

Siegel, L., & Siegel, L. C. Educational set: A determinant of acquisition. Journal of Educational Psychology, 1965, 56, 1-12.

Sigel, I. E. Sigel cognitive style test. Detroit: Merrill Palmer Institute, 1967.

Singer, R. N. To err or not to err: A question for the instruction of psychomotor skills. Review of Educational Research, 1977, 47(3), 479-498.

Singer, R. N. Motor skills and learner strategies. In H. F. O'Neil, Jr. (Ed.), Learning strategies. New York: Academic Press, 1978.

Singer, R. N., & Gaines, L. Effect of prompted and trial-and-error learning on transfer performance of a serial motor task. American Educational Research Journal, 1975, 12, 395-403.

Singer, R. N., & Pease, D. The effect of different instructional strategies on learning, retention, and transfer of a serial motor task. Research Quarterly, 1976, 47, 788-796.

Skinner, B. F. An operant analysis of problem solving. In B. Kleinmuntz (Ed.), Problem solving: Research, method, and theory. New York: Wiley, 1966, 225-257.

Snow, R. E. Individual differences, instructional theory, and instructional design. (Tech. Rep. No 4) Aptitude Research Project, School of Education, Stanford University (ARPA Contract No. N00014-75-C-0882) June, 1977.

Sonstroem, A. M. On the conservation of solids. In J. S. Bruner, R. R. Olver, & P. M. Greenfield (Eds.), Studies in cognitive growth. New York: Wiley, 1966.

Spilich, G. J., Vesonder, G. T., Chiesi, H. L., & Voss, J. F. Text processing of domain-related information for individuals with high and low domain knowledge. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 275-290.

Steffenson, M. S., Jogdeo, C., & Anderson, R. C. A cross-cultural perspective on reading comprehension (Tech. Rep. 97). Champaign Illinois: University of Illinois, Center for the Study of Reading, July, 1978.

Stevenson, H. W., & Siegel, A. Effects of instruction and age on retention of filmed content. Journal of Educational Psychology, 1969, 60, 71-74.

Sticht, T. G., & Zapf, D. W. Reading and readability in the armed services. Alexandria, Virginia: Human Resources Research Organization, September, 1976. HumRRO FR-WD-CA-76-4.

Stratton, R. P., & Brown, R. Improving creative thinking by training in the production and/or judgment of solutions. Journal of Educational Psychology, 1972, 63(4), 390-397.

Streufert, S., Clardy, M., Driver, M., Karlins, M., Schroder, H., & Suedfeld, P. A tactical game for the analysis of complex decision making in individuals and groups. Psychological Reports, 1965, 17, 723-729.

Stromnes, F. J., & Nyman, J. Immediate and long-term retention of connected concrete discourse as a function of mnemonic picture-type sequence and context. Scandinavian Journal of Psychology, 1974, 15, 197-202.

Stuart, I. R. Perceptual style and reading ability: Implications for an instructional approach. Perceptual and Motor Skills, 1967, 24, 130-138.

Suedfeld, P., & Hagen, R. L. Measurement of information complexity: I. Conceptual structure and information pattern as factors in information processing. Journal of Personality and Social Psychology, 1966, 4, 233-236.

Sulin, R. A., & Dooling, D. J. Intrusion of a thematic idea in retention of prose. Journal of Experimental Psychology, 1974, 103, 255-262.

Taylor, W. L. Cloze procedure: A new tool for measuring readability. Journalism Quarterly, 1953, 30, 415-433.

Thorndyke, P. W. Cognitive structures in comprehension and memory of narrative discourse. Cognitive Psychology, 1977, 9, 77-110.

Thornton, C. C., Barrett, G. V., & Davis, J. A. Field dependence and target identification. Human Factors, 1968, 10, 493-496.

Torrance, E. P. Role of evaluation in creative thinking. Bureau of Educational Research, University of Minnesota, 1964.

Trollip, S. R. The evaluation of a complex computer-based flight procedures trainer. Human Factors, 1979, 21(1), 47-54.

Trueblood, C. R. A comparison of two techniques for using visual-tactual devices to teach exponents and nondecimal bases in elementary school mathematics. The Arithmetic Teacher, 1970, 17, 338-340.

Tulving, E. Episodic and semantic memory. In E. Tulving and W. Donaldson (Eds.), Organization of Memory. New York: Academic Press, 1972.

Valverde, H. H. A. A review of flight simulator transfer of training studies. Human Factors, 1973, 15, 510-523.

Van Dijk, T. A., & Kintsch, W. Cognitive psychology and discourse. In W. Dressler (Ed.), Current trends in textlinguistics. Berlin, W. Germany: deGruyter, 1977.

Van Mondfrans, A. P. & Travers, R. Learning of redundant material presented through two sensory modalities. Perceptual and Motor Skills, 1964, 19(3), 743-751.

VanZoost, F. L., & Jackson, B. T. Effects of self-monitoring and self-administered reinforcement on study behaviors. Journal of Educational Research, 1974, 67(5), 216-218.

Voss, J. F. Cognition and instruction: Toward a cognitive theory of learning. In A. M. Lesgold, J. W. Pellegrino, S. D. Fokkema, & R. Glaser (Eds.), Cognitive psychology and instruction. New York: Plenum Press, 1978.

Wallach, M. A. & Caron, A. J. Attribute criteriality and sex-linked conservatism as determinants of psychological similarity. Journal of Abnormal and Social Psychology, 1959, 59, 43-50.

Wanshura, P. B., & Borkowski, J. G. Development and transfer of mediational strategies by retarded children in pair-associated learning. American Journal of Mental Deficiency, 1974, 78, 631-639.

Warren, T. F., & Davis, G. A. Techniques for creative thinking: An empirical comparison of three methods. Psychological Reports, 1969, 25, 207-214.

Watts, G. H., & Anderson, R. C. ffects of three types of inserted questions on learning from prose. Journal of Educational Psychology, 1971, 62, 38 -394.

Weinstein, C. E. Learning of elaboration strategies. Unpublished doctoral dissertation, University of Texas at Austin, 1975.

Weinstein, C. E. Elaboration skills as a learning strategy. In H. F. O'Neil, Jr. (Ed.), Learning strategies. New York: Academic Press, 1978.

Weisskopf-Joelson, E., & Eliseo, T. S. An experimental study of the effectiveness of brainstorming. Journal of Applied Psychology, 1961, 45, 45-49.

Whitehill, R. P. The development of effective learning skills programs. Journal of Educational Research, 1972, 65(6), 281-285.

Winograd, T. Understanding natural language. New York: Academic Press, 1972.

Witkin, H. A. Embedded figures test. Consulting Psychologists Press, Inc.: California, 1971.

Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodenough, D. R., & Karp, S. A. Psychological differentiation: Studies of development. New York: Wiley, 1962.

Witkin, H. A., Goodenough, D. R., & Karp, S. A. Stability of cognitive style from childhood to young adulthood. Journal of Personality and Social Psychology, 1967, 7, 291-300.

Witkin, H. A., Lewis, H. B., Hertzman, M., Machover, K., Meissner, P. B., & Wapner, S. Personality through perception. New York: Harper, 1954.

Witkin, H. A., Lewis, H. B., & Weil, E. Affective reactions and patient-therapist interactions among more differentiated and less differentiated patients early in therapy. The Journal of Nervous and Mental Disease, 1968, 146, 193-206.

Wittrock, M. C. The cognitive movement in instruction. Educational Psychologist, 1979,

Wittrock, M. C., & Carter, J. Generative processing of hierarchically organized words. American Journal of Psychology, 1975, 88, 489-501.

Wolpe, J. The practice of behavioral therapy. New York: Pergamon, 1969.

Yuille, J., & Catchpole, M. Effects of delay and imagery training on the recall and recognition of object pairs. Journal of Experimental Child Psychology, 1974, 17, 474-481.

Zimmerman, B. J., & Rosenthal, T. L. Observational learning of rule-governed behavior by children. Psychological Bulletin, 1974, 81, 24-42.

END

DEPT. OF EDUCATION

NAT'L INSTITUTE OF EDUCATION

ERIC

DATE FILMED

JANUARY

28 – 1985